



UNIVERSITY of BAYREUTH
Department of Micrometeorology

The Arctic Turbulence Experiment 2006

**Direct measurements of turbulent fluxes in the near
surface environment at high latitudes applying the
eddy-covariance method**



PART 3

Aerological measurements during the

ARCTEX 2006 campaign

May, 2nd to May, 20th 2006

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1 Introduction

Abstract

Accurate quantification of turbulent fluxes between the surface and the atmospheric boundary layer in polar environments, characterized by frequent stable to very stable stratified conditions, is a fundamental problem in soil-snow-ice-vegetation-atmosphere interaction studies. The observed rapid climate warming in the Arctic requires improvements in the monitoring of energy and matter exchange; accomplished by setting up appropriate (adapted to polar conditions) observation sites to measure turbulent fluxes. To address these problems, it is essential to improve the databases with high-quality in-situ measurements of turbulent fluxes near the surface applying the Eddy-Covariance method.

These direct measurement data (CSAT3 sonic anemometer, KH20 krypton hygrometer, and laser scintillometer) obtained during the first Arctic Turbulence Experiment (ARCTEX-2006) in May 2006 at the French-German Arctic Research Base in Ny-Ålesund (AWI/IPEV) on Spitsbergen (Svalbard) allowed a comparison with simulated results from simple flux gradient-parameterizations used today to force atmosphere-ocean-ice models. In addition, the results of this pilot study shows the problem of direct measurements (e.g. snow drift through the sensor path ways) under rough weather conditions as well as they reveal that the misestimating of sensible heat fluxes can result from inaccurate measurements or calculation of the surface temperature and inappropriate treatment of the neutral and stable conditions (e.g. intermittency, gravity waves) in the bulk parameterization.

The primary goals of the ARCTEX-campaign were:

1. continuous measurements of high-resolution (20 Hz) turbulent heat fluxes near the tundra surface using a ultra sonic anemometer (eddy-covariance method) and an ultraviolet krypton hygrometer,
2. continuous measurements of the turbulent sensible heat flux near the tundra surface using the Laser-scintillometry,
3. measurements of standard meteorological data sampled at 1s intervals using a meteorological gradient tower (6 m and 10 m),
4. pre- and post- processing of high-quality data sets of turbulent fluxes using state of the art flux data quality assessment techniques,
5. understanding of exchange processes and their parameterization for neutral and stable conditions,
6. validation of commonly used sensible and latent heat flux parameterizations (aerodynamic approach, bulk and gradient method).

2 General Information

2.1 Location

Detailed geographic locations of the “Arctic Turbulence Experiment 2006” (ARCTEX-2006) at Ny-Ålesund (Svalbard, Kongsfjorden), May 2006, Universities of Bayreuth and Trier, Germany:

General location	Svalbard, Kongsfjorden, Ny-Ålesund, Position (Center of settlement): 078° 55' 24" N, 011° 55' 15" E	
Eddy-Flux complex UBT (EF):	Coordinates:	078° 55' 02" N, 011° 55' 52" E
	Altitude:	13 m a. s. l.
	Land use:	snow covered tundra
Meteorological tower AWI (MT1):	Coordinates:	078° 55' 04" N, 011° 55' 26" E
	Altitude:	14 m a. s. l.
	Land use:	snow covered tundra
Meteorological tower UBT (MT2):	Coordinates:	078° 55' 03" N, 011° 55' 34" E
	Altitude:	14 m a. s. l.
	Land use:	snow covered tundra
Scintillometer UBT (SLS):	Coordinates:	078° 55' 00" N, 011° 56' 00" E
	Altitude:	13.5 m a. s. l.
	Land use:	snow covered tundra
Tethered balloon AWI (TB1):	Coordinates:	078° 55' 06" N, 011° 55' 23" E
	Altitude:	11 m a. s. l.
	Land use:	snow covered tundra
Tethered balloon AWI (TB2):	Coordinates:	078° 55' 27" N, 011° 56' 07" E
	Altitude:	3 m a. s. l.
	Land use:	Harbor (concrete), fjord (water)
Radiosonde AWI (RS):	Coordinates:	078° 55' 06" N, 011° 55' 23" E
	Altitude:	11 m a. s. l.
	Land use:	snow covered tundra
BSRN AWI (BSRN):	Coordinates:	078° 56' 05" N, 011° 56' E
	Altitude:	11 m a. s. l.
	Land use:	snow covered tundra
Time zone		Central European Time: CET = GMT + 1 h (winter) CEST = GMT + 2 h (summer). Given times and filenames reflect starting time of intervals

UBT=Univ. of Bayreuth; AWI= Alfred Wegener Institute for Polar- and Marine Research; BSRN= Baseline Surface Radiation Network

2.2 Surface and weather conditions

Table 2.1 lists the surface and weather conditions during the ARCTEX-2006 campaign. Noteworthy, is the extreme warm period until evening May 7 and the heavy snow-storm at night, May 7 to May 8.

Table 2.1: Surface and weather conditions during the ARCTEX-2006 campaign.

May 3 to May 5	wet melting snow over ice, larger snow free spots (bare soil, tundra), surface melt water, some rain fall and partly cloudy, Arctic Haze event, extremely warm, temperature range: +3 °C to +8 °C
May 6 to May 8	1 st storm and heavy snowfall, heavy snowdrift; overcast weather, extremely warm (+8 °C) until beginning of the 2 nd storm on May 7, 19 h CET and temperature drop of more than 16 K (−10 °C)
May 9 to May 11	fresh snow cover, predominantly sunny weather, temperature range: −5 °C to −2 °C
May 12 to May 14	ongoing snowdrift, snow cover depleting, at 13 th pm temperature around 0 °C, predominantly overcast or partly cloudy weather, temperature range: −4 °C to 0 °C
May 15 to May 16	ongoing snowdrift, some snow free spots, at ground refrozen and compacted thin ice layers, predominantly sunny or partly cloudy weather, temperature range: −4 °C to −1 °C
May 17 to May 19	melting snow over ice, some snow free spots (bare soil, tundra), light to moderate rain and/or snowfall (17 th and 18 th , temperature range: −2 °C to +1 °C)

3 Overview of measurement sites

3.1 Maps and photographs

The map (Figure 3.1) of Ny-Ålesund (Svalbard) shows the measurement sites during the ARCTEX-2006 campaign. The permanent AWI/IPEV sites used for this study are the 10 m meteorological tower of the Alfred Wegener Institute for Polar and Marine Research (MT1), the international standardized radiation measurements of the Baseline Surface Radiation Network (BSRN), the WMO 1004 radiosonde launch site (RS) and the temporary AWI tethered balloon launch sites TB1 and TB2. The temporary sites - build up by the Universities of Bayreuth and Trier - are the 6 m meteorological tower (MT2), the eddy-flux measurement complex with sonic anemometer (EF), and the Laser-scintillometer pathway (SLS).

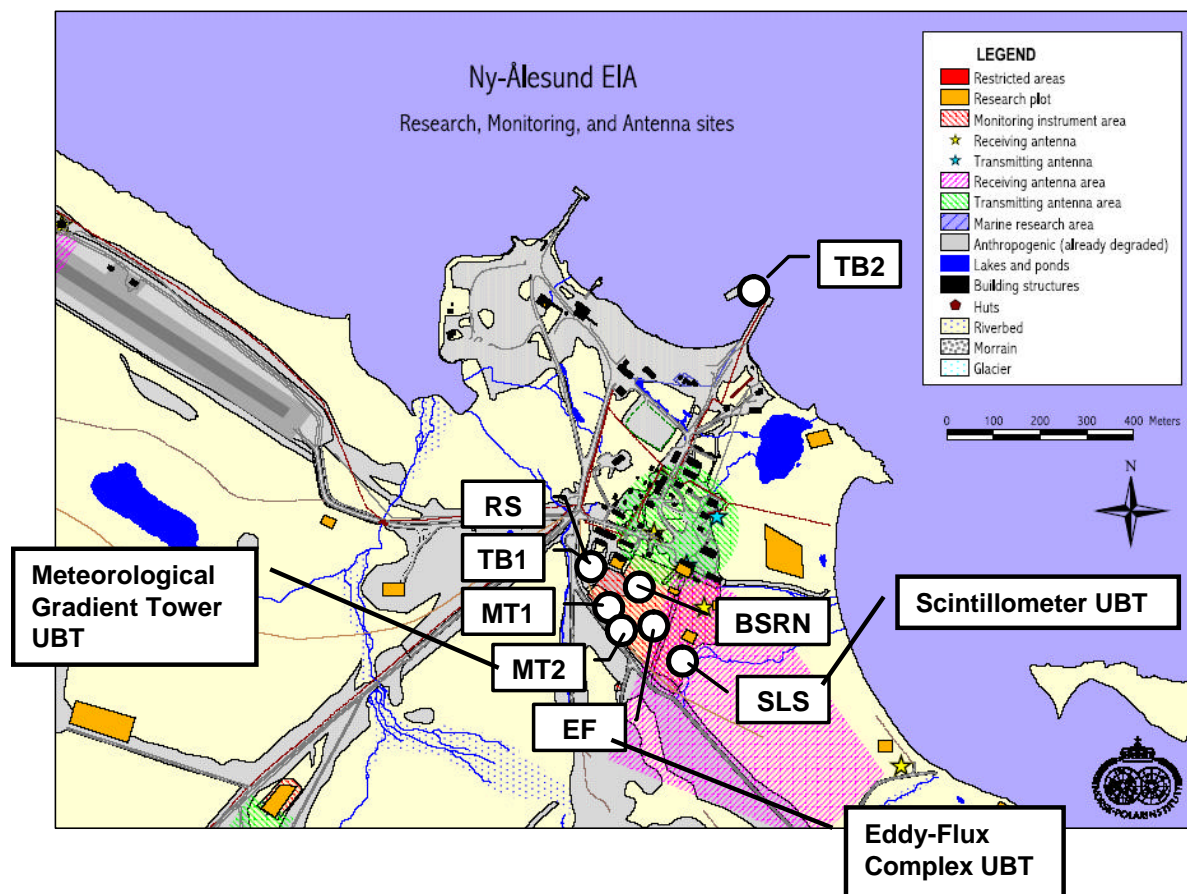


Figure 3.1: Map of Ny-Ålesund (Svalbard, Kongsfjorden) showing the measurement sites during the ARCTEX-2006 campaign: MT1 (10 m meteorological tower of the Alfred Wegener Institute for Polar and Marine Research), MT2 (6 m meteorological tower of the University of Bayreuth), EF (eddy-flux measurement complex), SLS (site for scintillometer measurements), BSRN (radiation measurements of the Baseline Surface Radiation Measurements), RS (radiosonde launch site), TB1 and TB2 (tethered balloon launch sites). The base map was kindly provided by the Norwegian Polar Institute.

3.1.1 AWI radiosonde launch site (RS)

The launch site for radiosondes is situated in the south-western part of Ny-Ålesund at 11.92°E, 78.92°N. The station is operated by the Alfred Wegener Institute for Polar and Marine Research (Figure 3.2).



Figure 3.2: Radiosonde launch at the Ny-Ålesund station (79° N, Svalbard, Kongsfjorden) in May 2006, operated by staff of the Alfred Wegener Institute for Polar and Marine Research.

3.1.2 AWI tethersonde launch sites (TB1, TB2)



Figure 3.3: Tethersonde sounding system at the Ny-Ålesund radiosonde station and at the harbor (Kongsfjorden) in May 2006 operated by staff of the Alfred Wegener Institute for Polar and Marine Research.

4 Detailed description of aerological instrumentation

4.1 Radiosonde

The radiosonde launch site (WMO 1004) at Ny-Ålesund is operated by the Alfred Wegener Institute for Polar and Marine Research. The radiosonde type used at this station during the ARCTEX campaign was the RS90-AG radiosonde of Vaisala including GPS-based wind receiving options (Figure 4.1). Except for 20 May 2006, the RS92-G radiosonde was launched. The RS90-AG routinely measures the variation of temperature, humidity, pressure, wind speed, and wind direction from the ground surface (11 m a.s.l.) to heights up to about 25 km to 37 km. During the radiosonde's flight, it constantly transmits the atmospheric data to automated receiving ground equipment (Figure 4.1). The Vaisala DigiCORA III sounding system processes and converts the data into meteorological weather messages that are sent to the global weather network. Once a week (Wednesdays), the ECC ozonesonde is used.

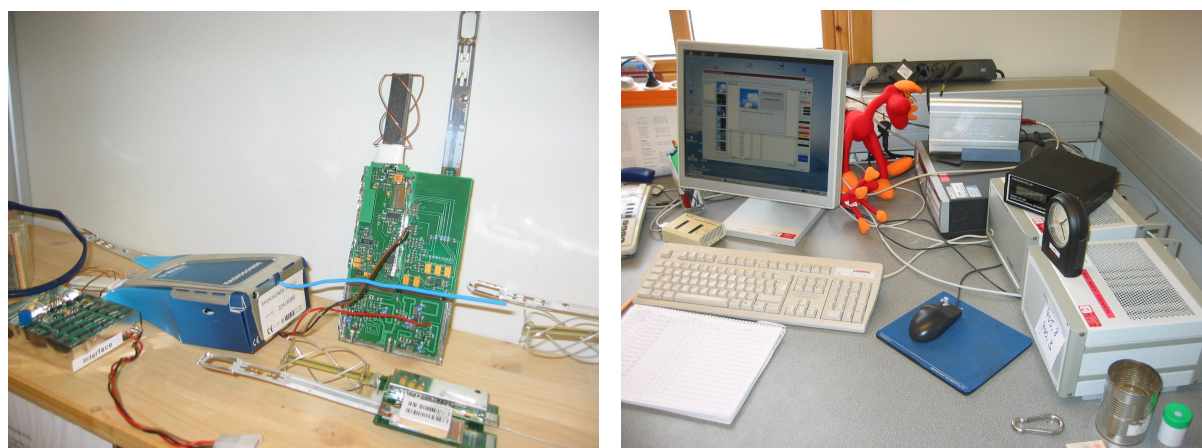


Figure 4.1: Standard radiosonde (RS90) and DigiCORA III sounding system (right), Vaisala.

The RS90-AG incorporates several fast response meteorological sensors: the F-Thermocap capacitive wire (air temperature), the self-defrosting H-Humicap thin film capacitor (humidity), the Barocap silicon micro-mechanical sensor (air pressure), and GPS (wind speed and direction). A detailed description of the sensors is given in Table 4.1.

Table 4.1: Technical information of the meteorological sensors used by the Vaisala RS90-AG Radiosonde.

	F-Themocap	H-Humicap	Barocap
Meteorological element	Temperature	Humidity	Pressure
Sensor type	Capacitive wire	Thin film capacitor	Silicon sensor
Measuring range	+60 °C to -90 °C	0% to 100%	1080 hPa to 3 hPa
Resolution	0.1 °C	1%	0.1 hPa
Accuracy: Repeatability	0.1 °C	2%	0.4 hPa
Accuracy: Uncertainty in sounding	0.5 °C	5%	1.5 hPa (1080-100 hPa)

The sampling rate is 1 s for each variable. On the contrary to the previous RS80 generation, the RS90 type radiosondes have an improved humidity sensor, which is designed to solve the problem of sensor icing at low temperatures and in clouds. All sensors are individually calibrated by Vaisala. The calibration equipment measures the output data of the radiosonde sensors in defined environmental conditions and then computes individual calibration coefficients for each sensor. The ground equipment uses these coefficients during sounding to calculate accurate measurement values from the sensor output data transmitted by the radiosonde. The frequency and timing of the upper-air observations in Ny-Ålesund does not coincide with other synoptic stations from the radiosonde network. There are no routine measurements at the standard times 0000, 0600, 1200, 1800 UTC and the frequency requirements by the WMO are not met. Upper air soundings over Ny-Ålesund are carried out routinely once a day normally between 10 and 12 UTC. The data is transmitted via the Global Telecommunication System (GTS) and flagged 1100 UTC. Additional soundings in combination with the tethered balloon were made on 10 and 11 May. Details about the starting time are listed in Table 4.2.

Table 4.2: Starting times at the Ny-Ålesund radiosonde station.

Date	Time (UTC)
01 May to 09 May 2006	1100 UTC
10 May 2006	1200 UTC to 2300 UTC
11 May 2006	0000 UTC to 1700 UTC
12 May to 20 May 2006	1100 UTC

The information on the launch is taken from the header of a sample record for both the RS-90 radiosonde and ECC ozonesonde. Launch details are presented in the appendix. From the raw data of both the RS-90 radiosonde and ECC ozonesonde only 1000 s after the launch are used for visualization. The regular time interval of data transmission is 5 s, for the high-resolution sounding on May 10 and May 11 the interval was changed to 1 s.

4.2 Tethersonde

The upper air sounding with radiosondes were accompanied at selected days with a Vaisala Tethersonde System (Figure 4.2). The aerodynamically stable tethered balloon was filled with helium and deployed by an electric winch comprising a heating device. The tethered balloon is suitable for wind speeds up to 15 m/s. The data were transmitted to the Vaisala DigiCORA III sounding system. The additional profiles of meteorological elements allow for a more detailed analysis of the atmospheric boundary layer. The system was used as a tower to measure atmospheric conditions at 6 levels simultaneously. Each of the six tethersondes (TTS111) measured temperature, humidity, pressure, wind speed and direction (Figure 4.2). The sensors deployed are the same used in the RS90. Wind speed is measured with a sensitive three-cup anemometer and a light-chopper tachometer. A small digital compass is used to measure wind direction. The technical details of the sensors for temperature, humidity, and pressure are presented in Table 4.1, for wind speed and direction in Table 4.3.

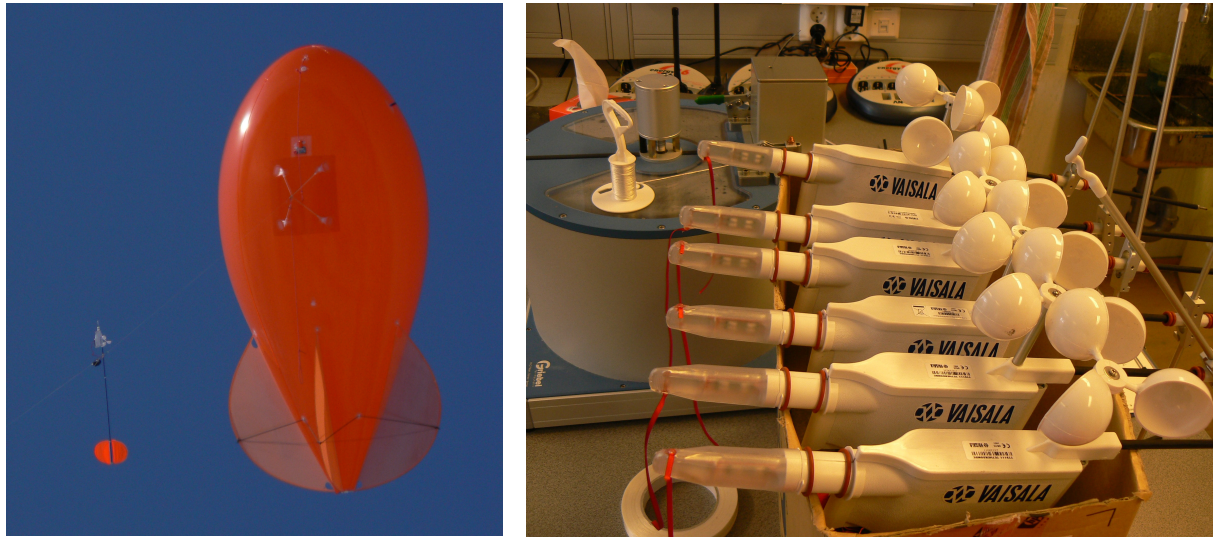


Figure 4.2: Tethersonde sounding system including tethered balloon and tethersondes (left) and six tethersondes TTS111 (right), Vaisala.

Table 4.3: Technical information of the meteorological sensors for wind speed and direction used by the Vaisala tethersonde TSS111.

	3-cup anemometer	Digital compass
Meteorological element	Wind speed	Wind direction
Measuring range	0 m/s to 20 m/s	0° to 360°
Resolution	0.1 m/s	1°

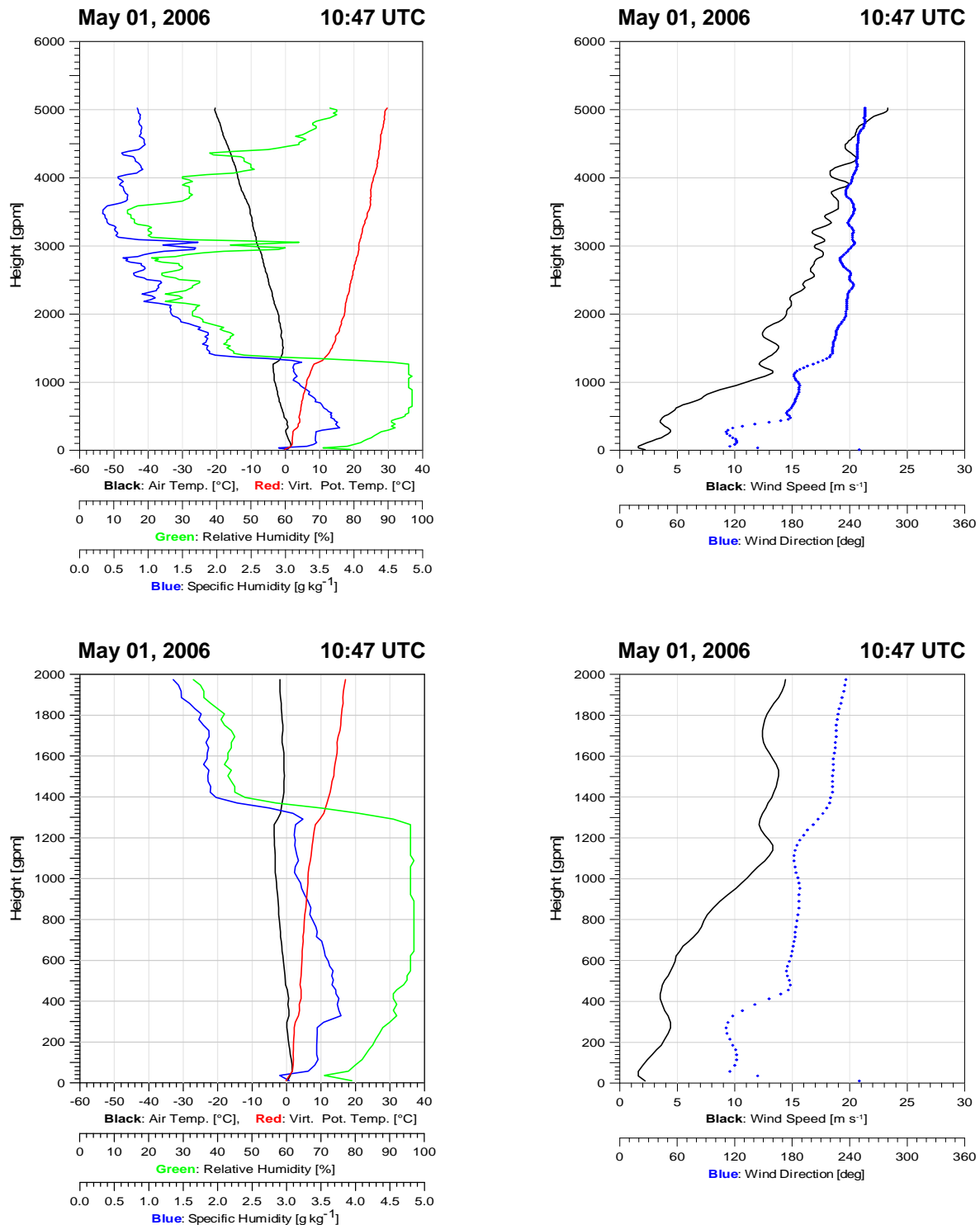
The tethersonde sounding system was used four times during the ARCTEX campaign (Table 4.4). The meteorological data was transmitted on the frequency 402.40 MHz (sonde 1), 402.85 MHz (sonde 2), 403.30 MHz (sonde 3), 403.70 MHz (sonde 4), 403.99 MHz (sonde 5), 404.29 MHz (sonde 6).

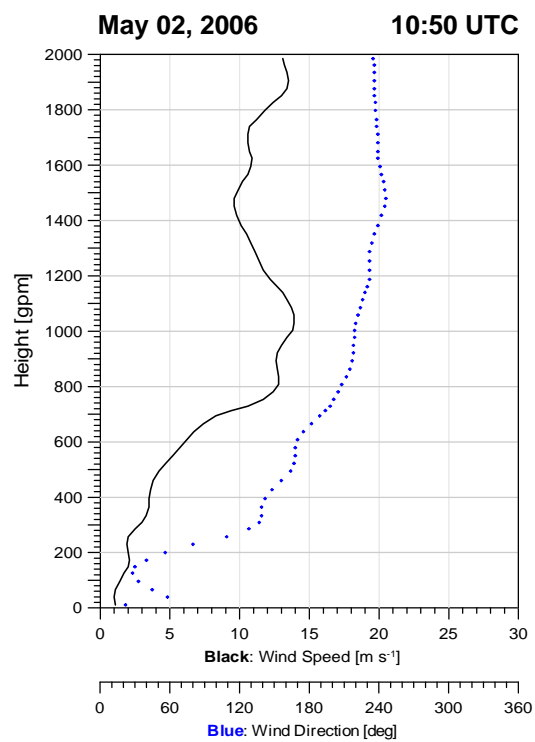
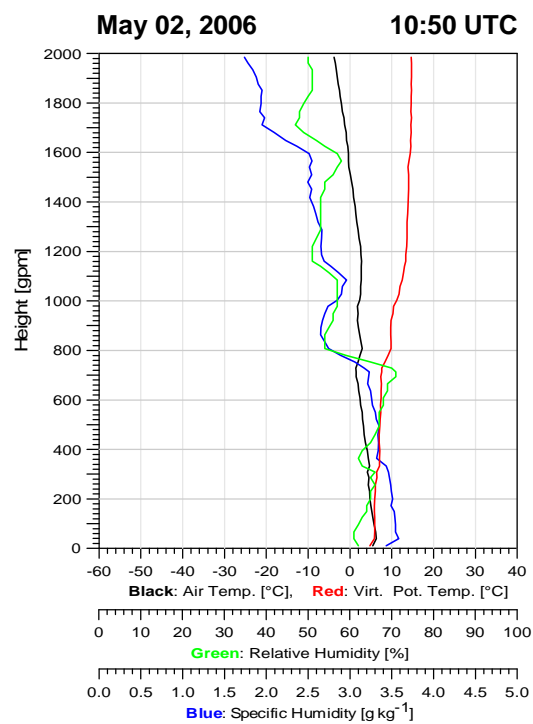
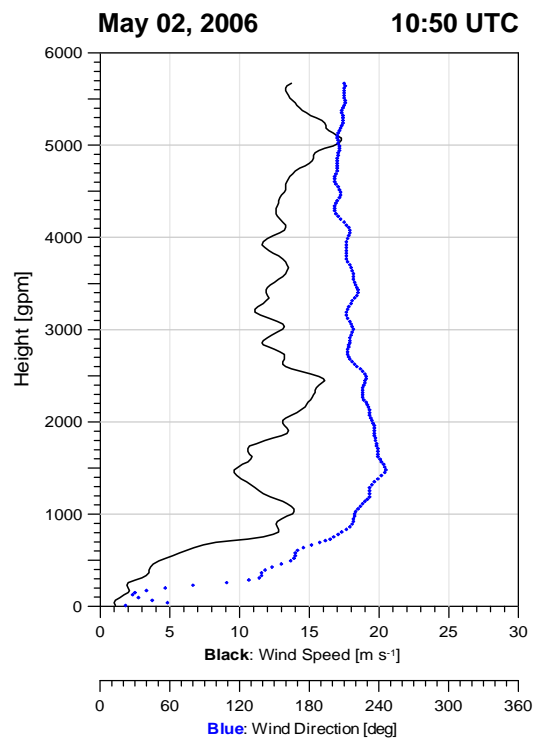
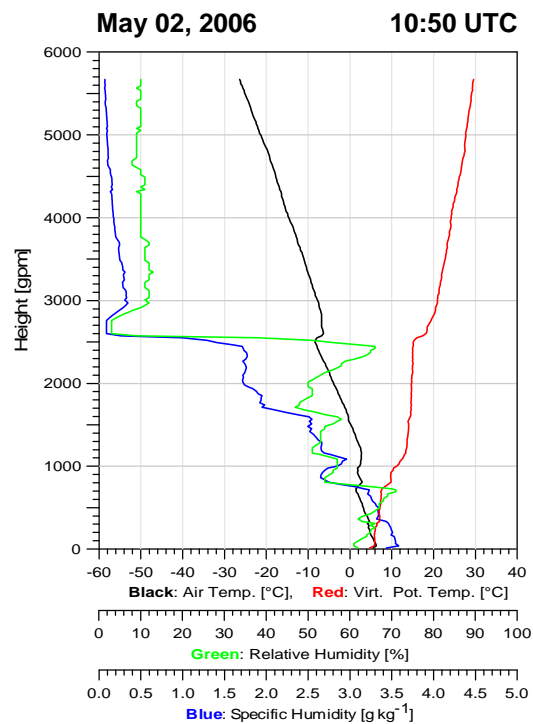
Table 4.4: Starting times, locations and maximum altitude of the tethersonde sounding over the Ny-Ålesund.

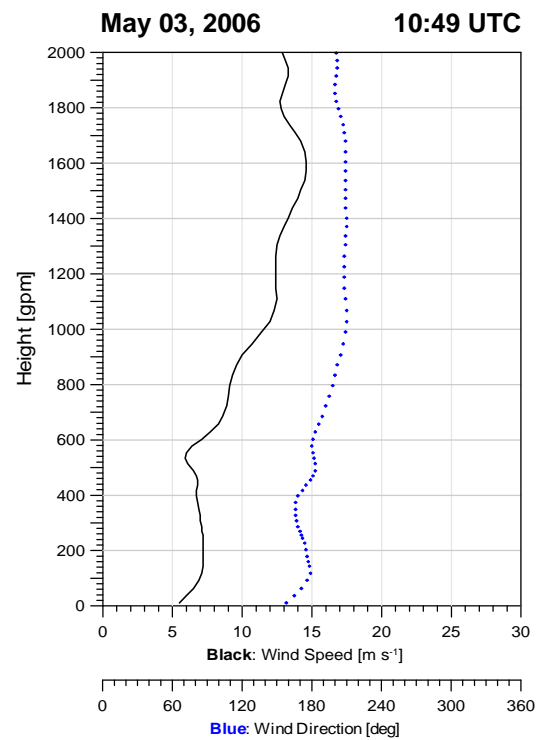
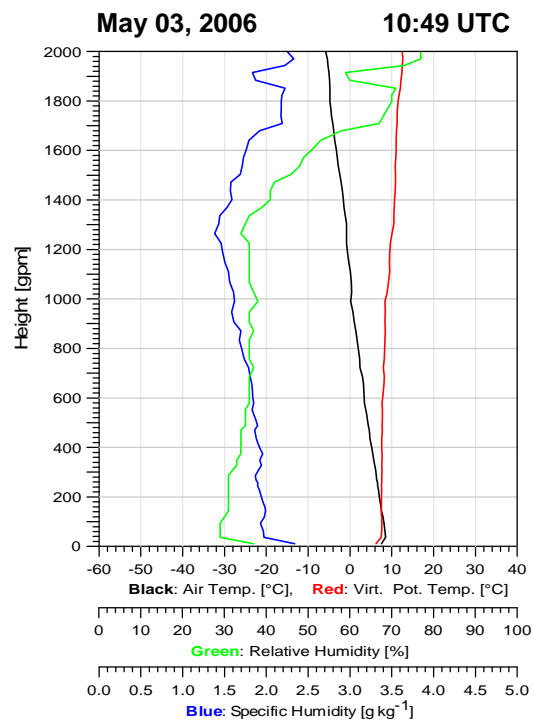
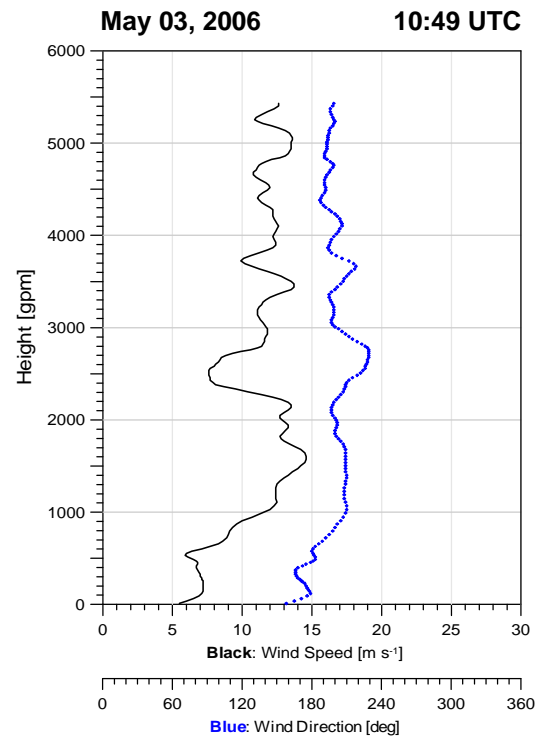
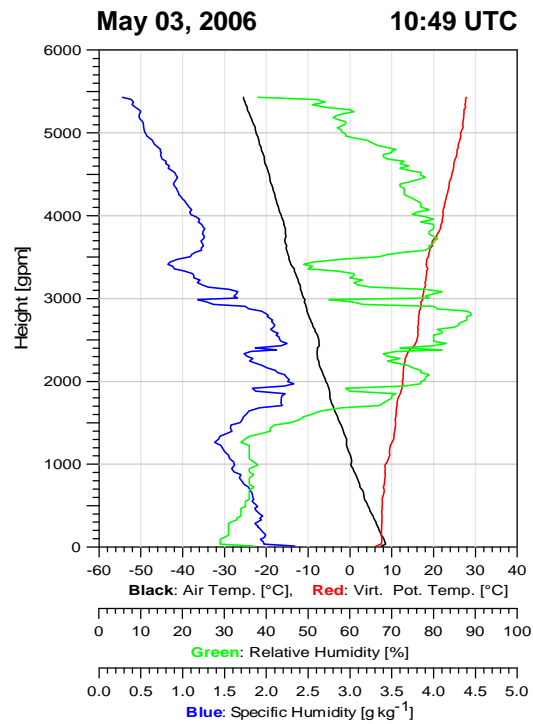
Date	Time (CEST)	Location	Maximum altitude
03 May 2006	1500 to 2300	Observatory	1200m
09 May to 10 May 2006	1400 to 0100	Observatory	1200 m
10 May 2006	0200 to 2200	Observatory	700 m
16 May 2006	1400 to 1800	Harbor	330 m

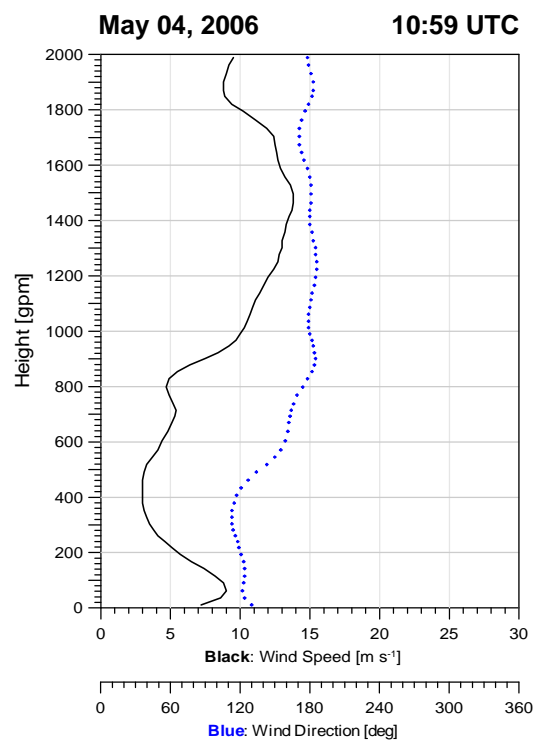
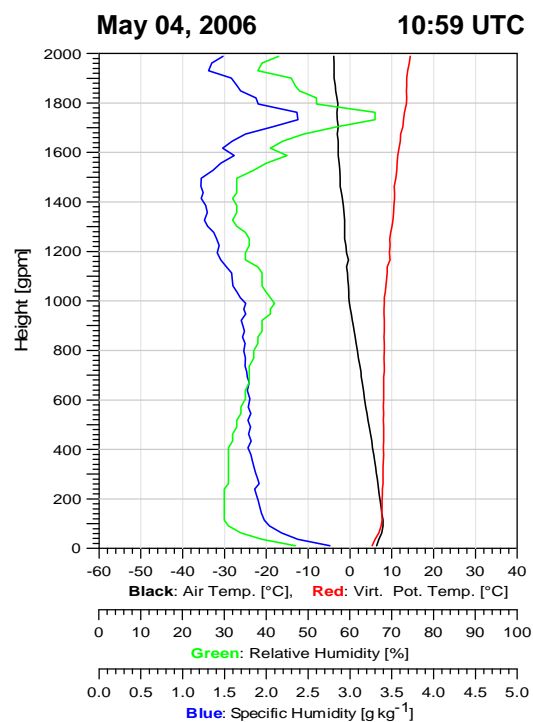
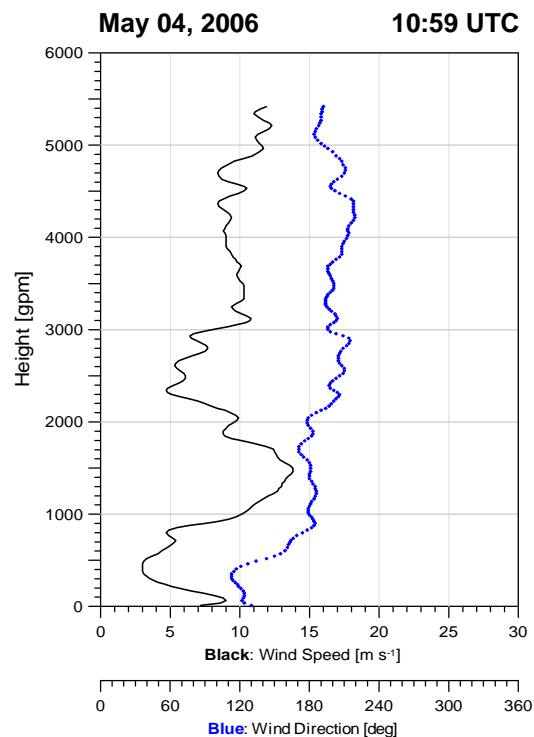
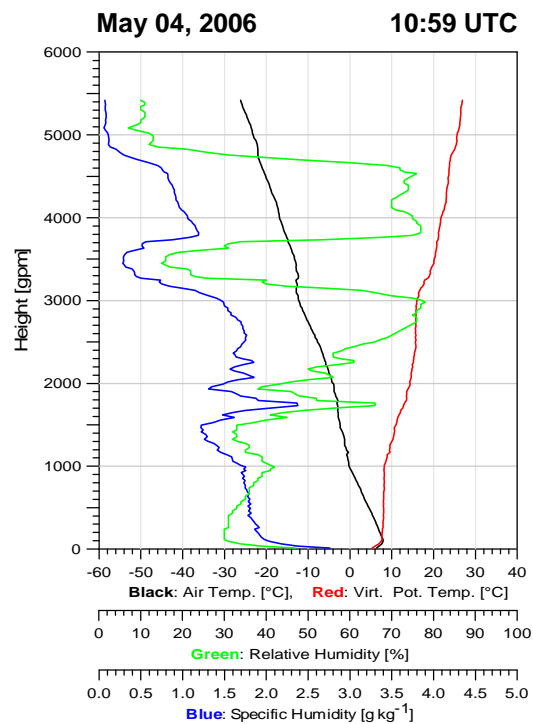
5 Visualization of aerological measurements

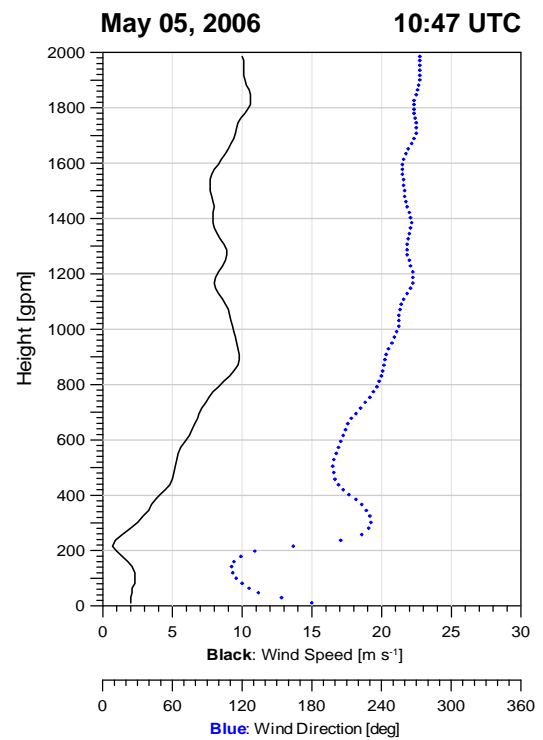
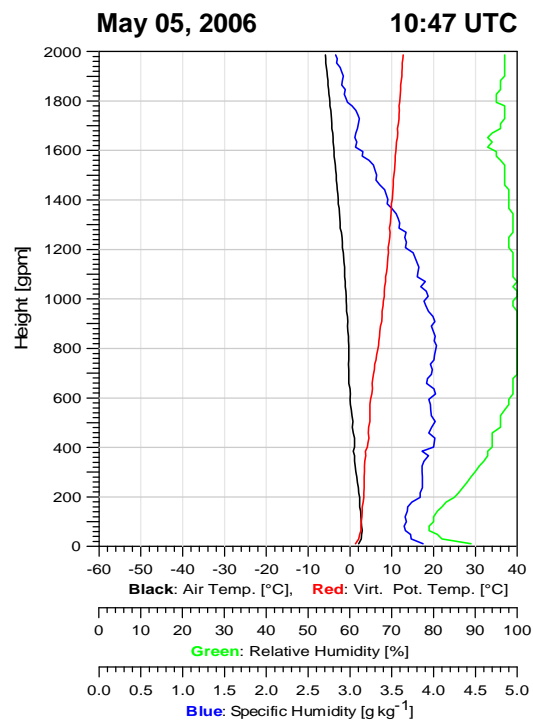
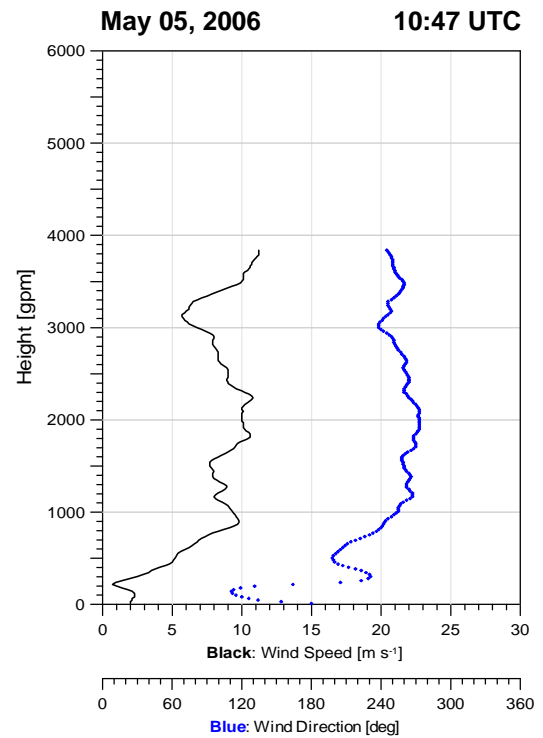
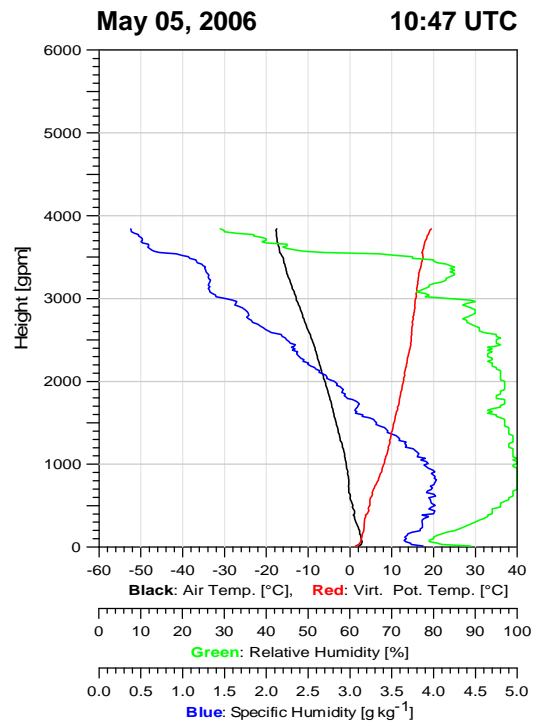
5.1 Radiosonde observations at Ny-Ålesund (WMO 1004)

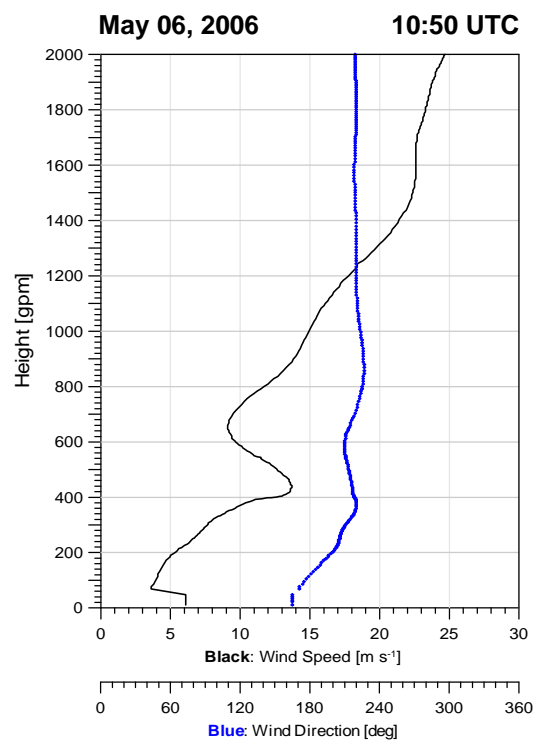
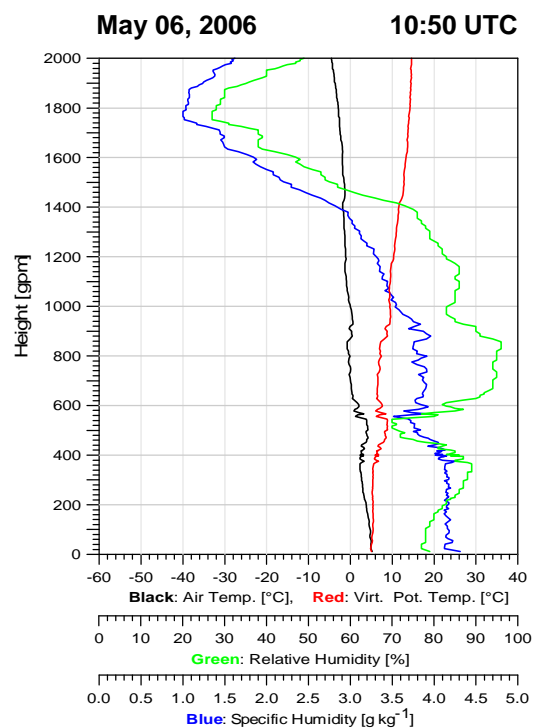
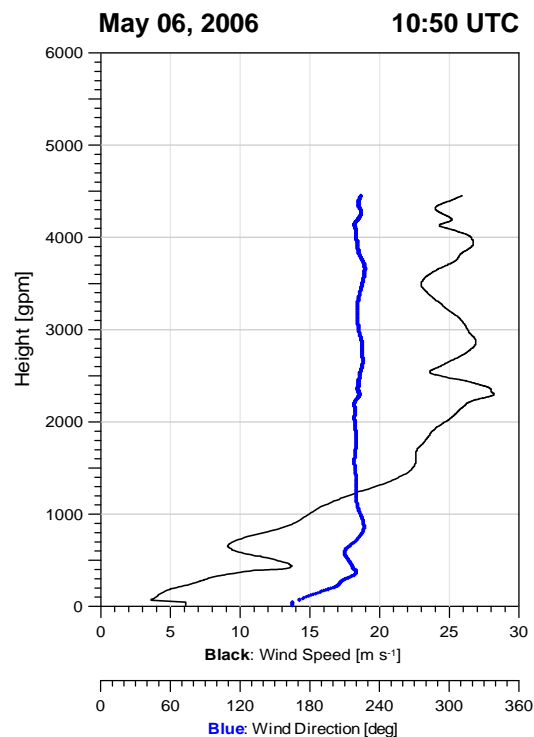
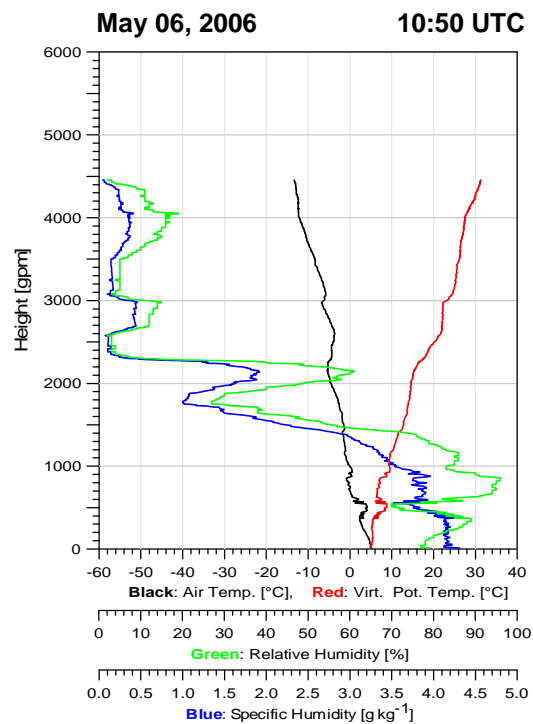


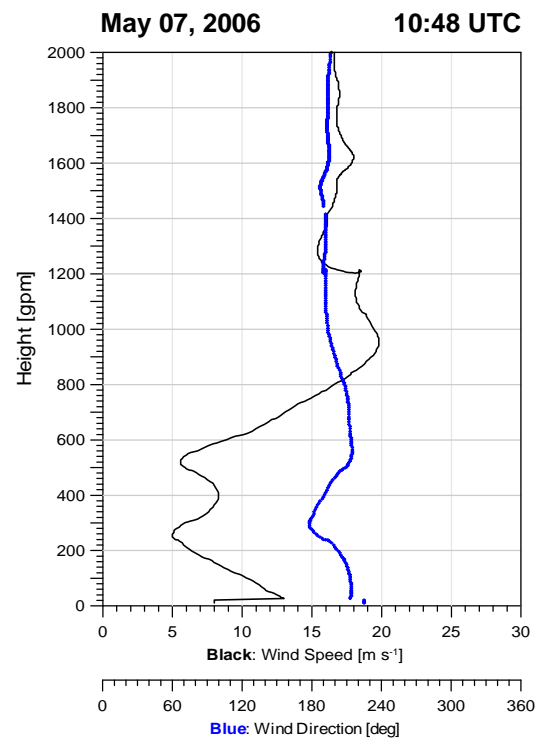
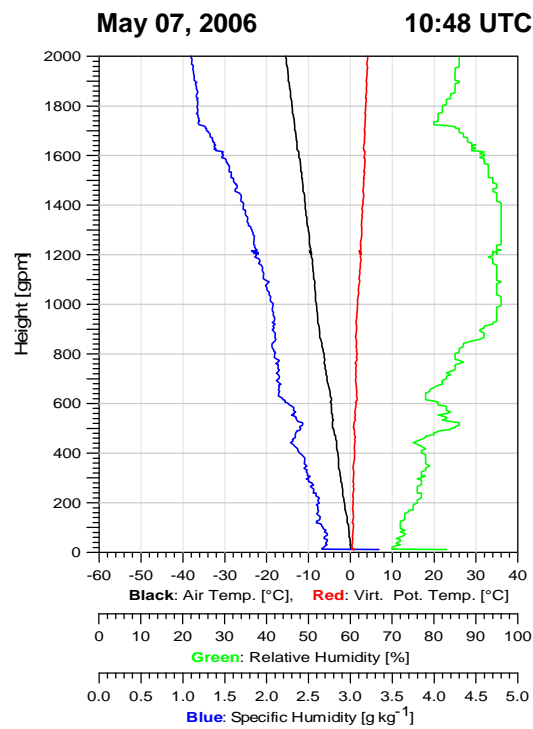
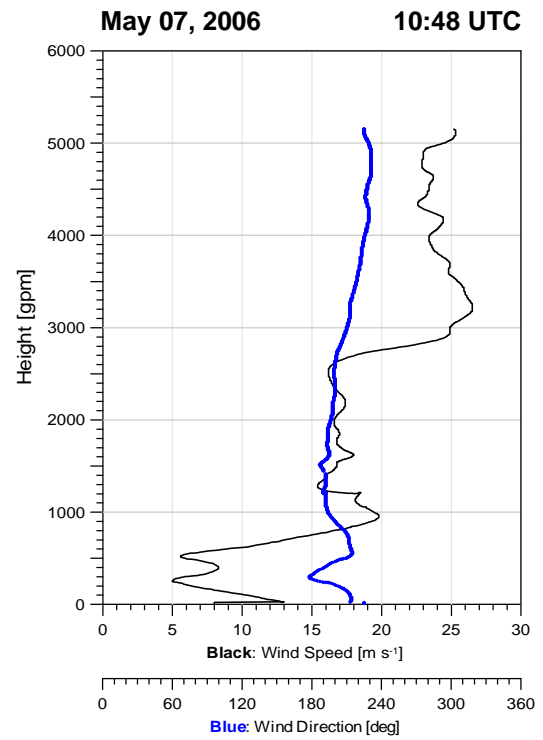
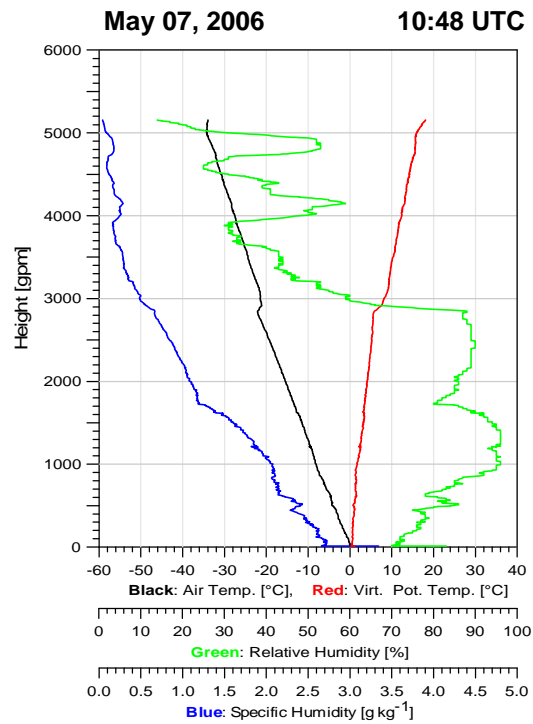


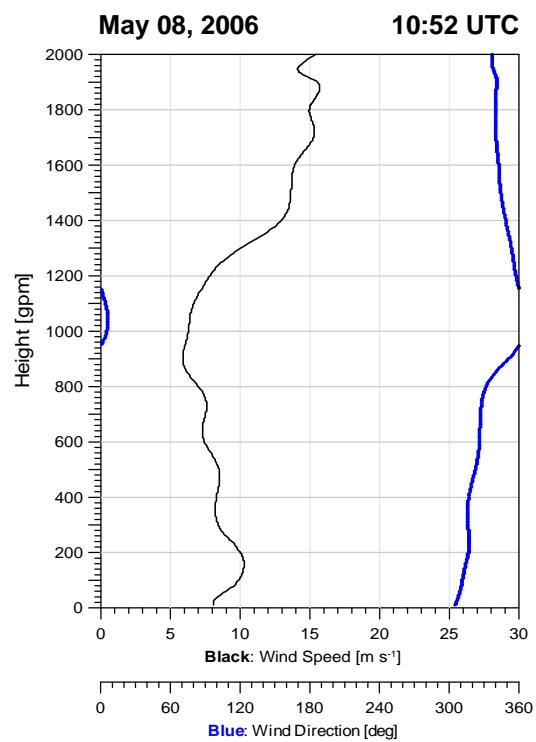
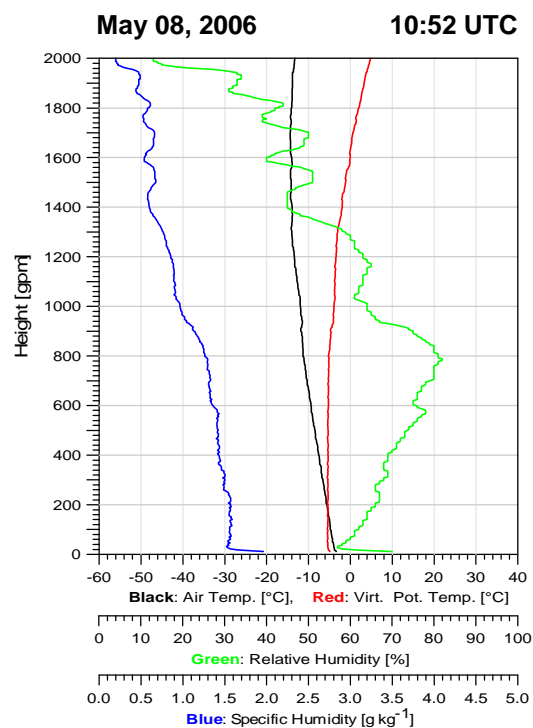
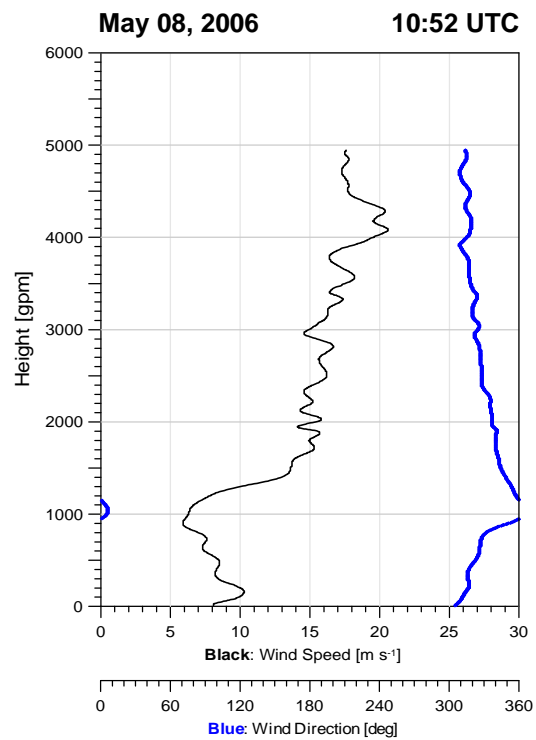
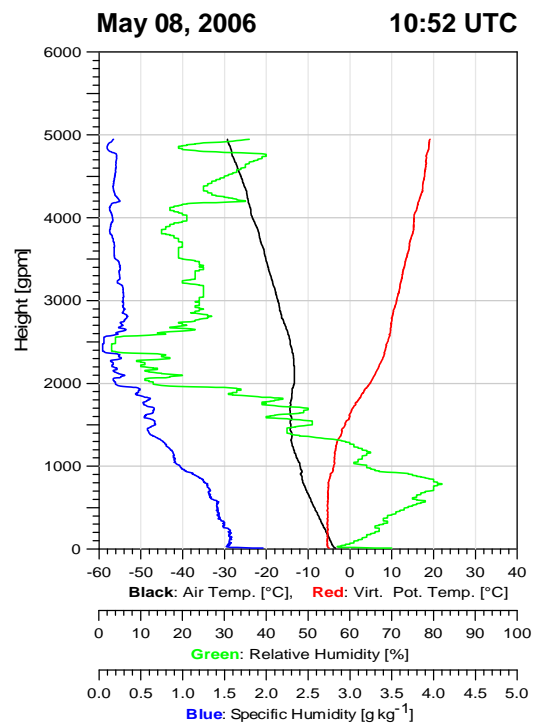


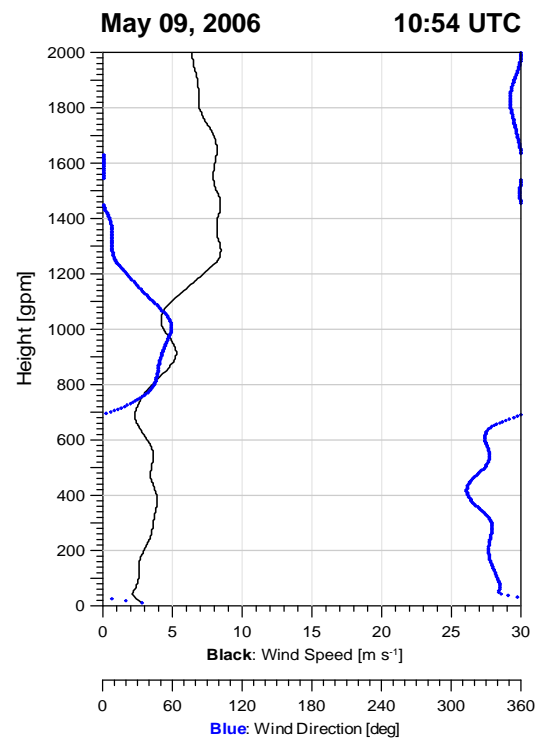
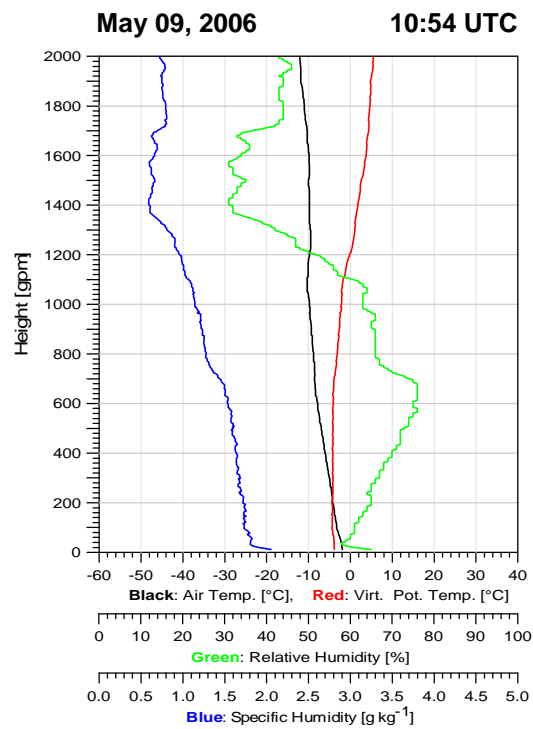
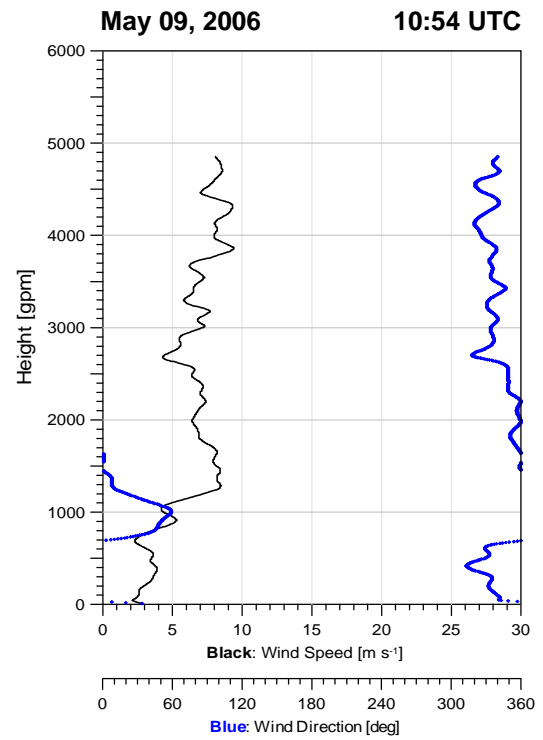
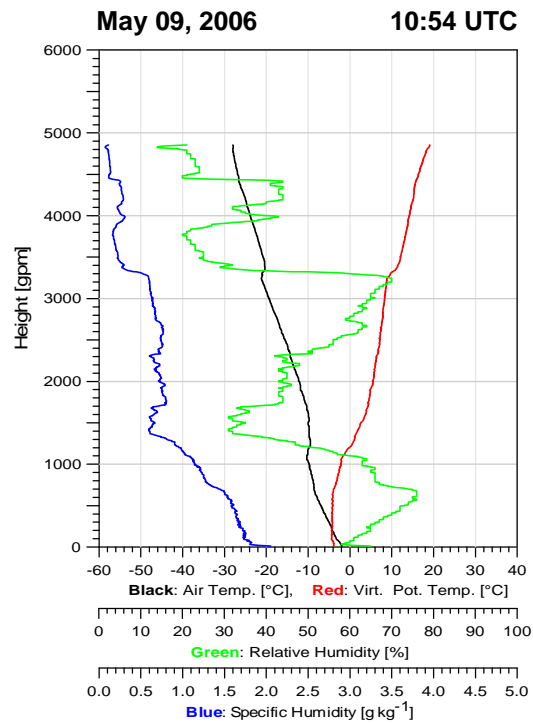


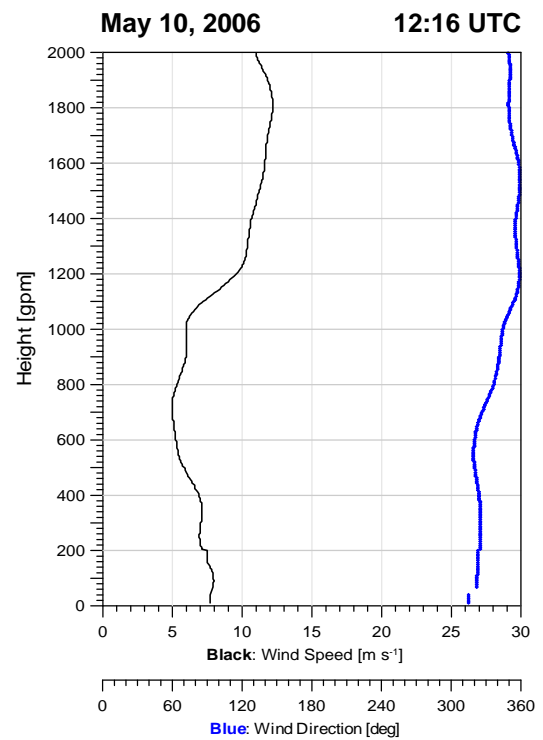
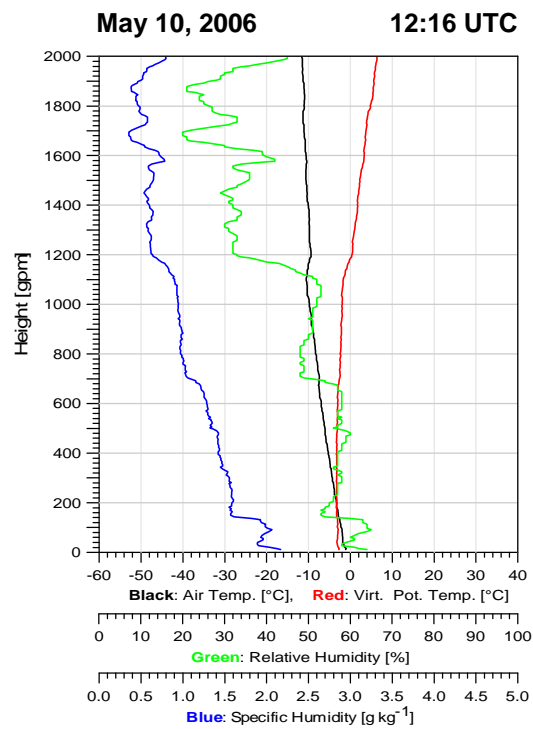
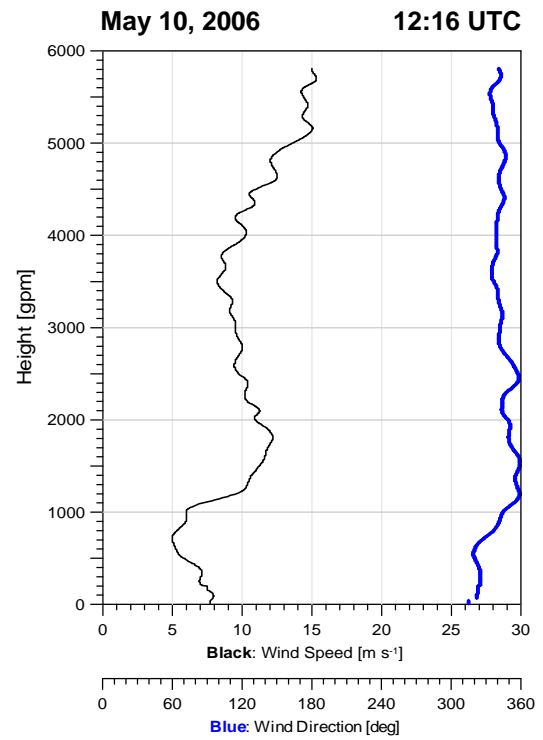
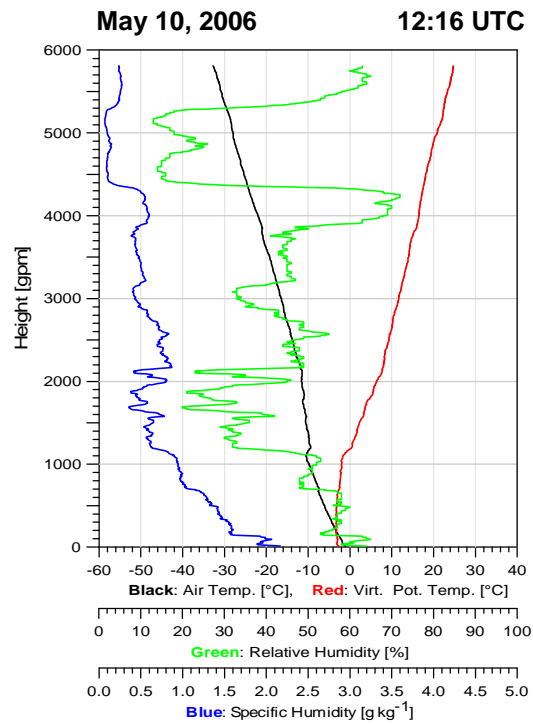


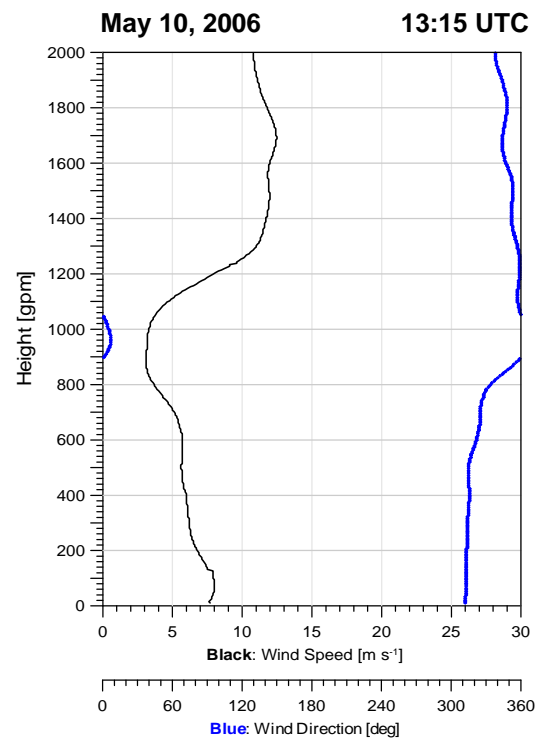
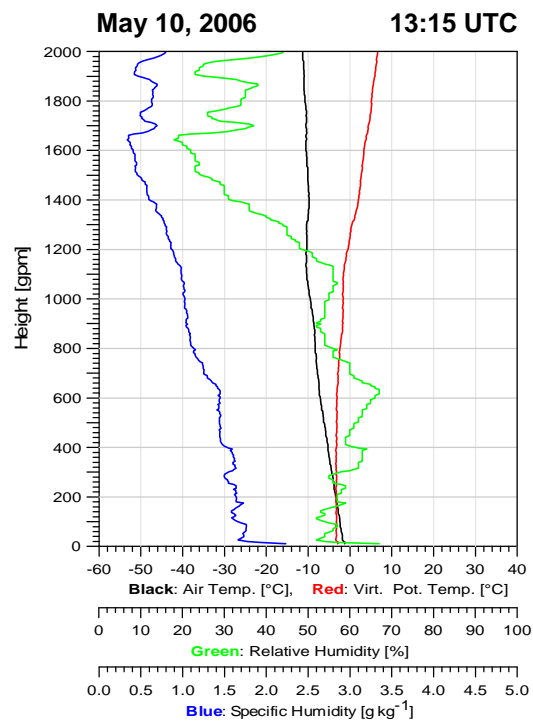
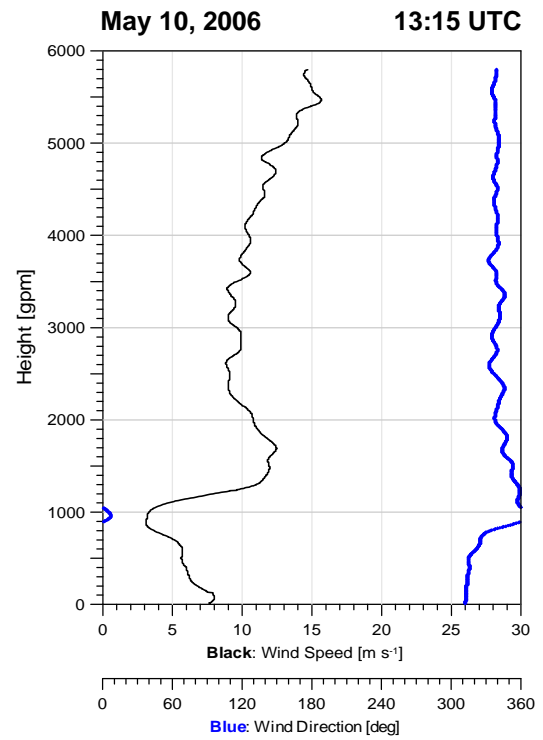
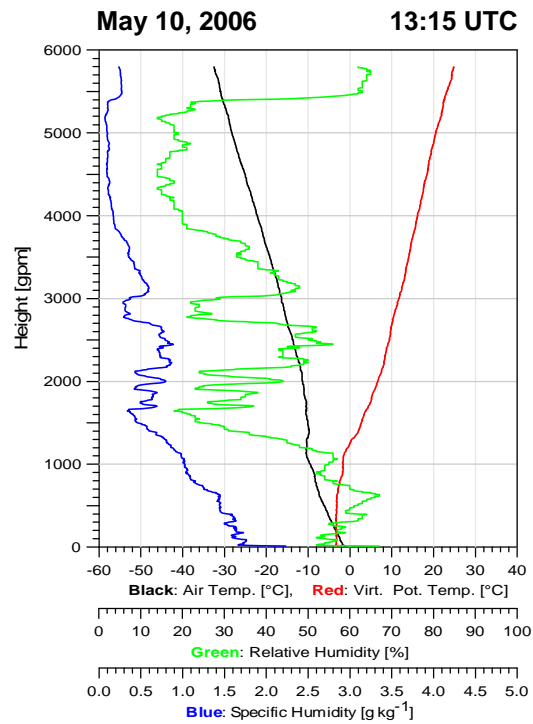


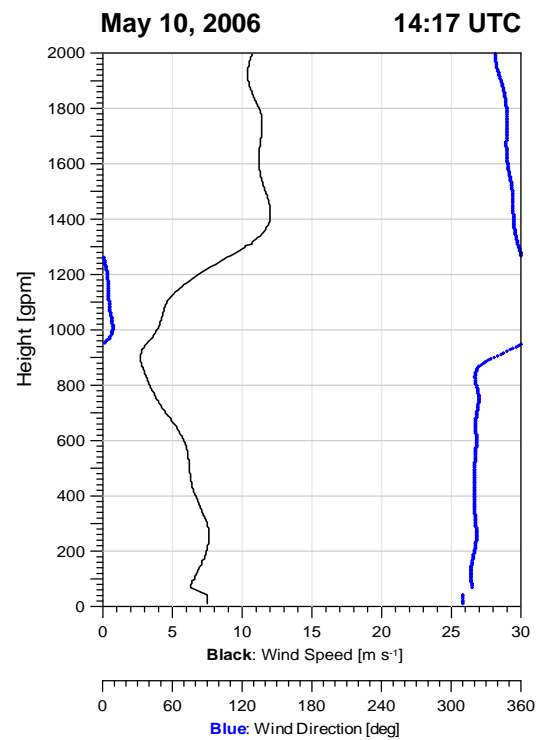
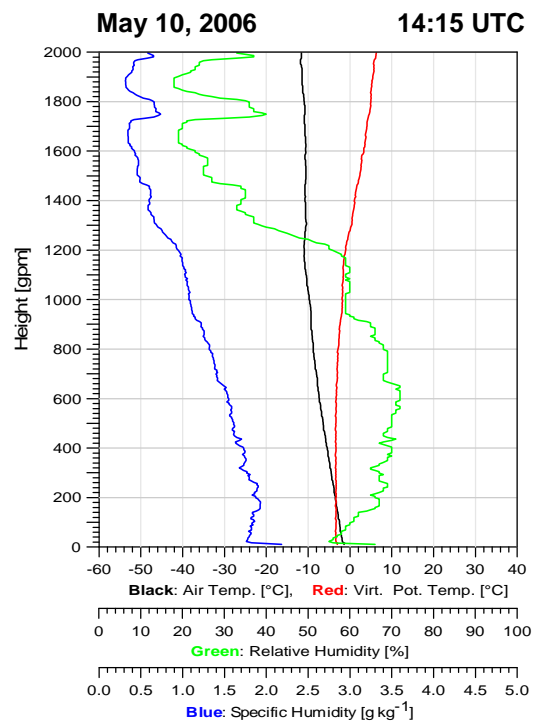
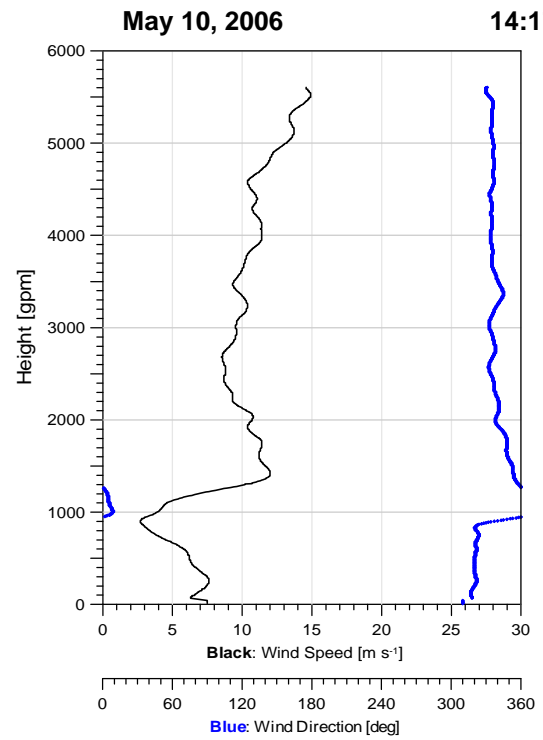
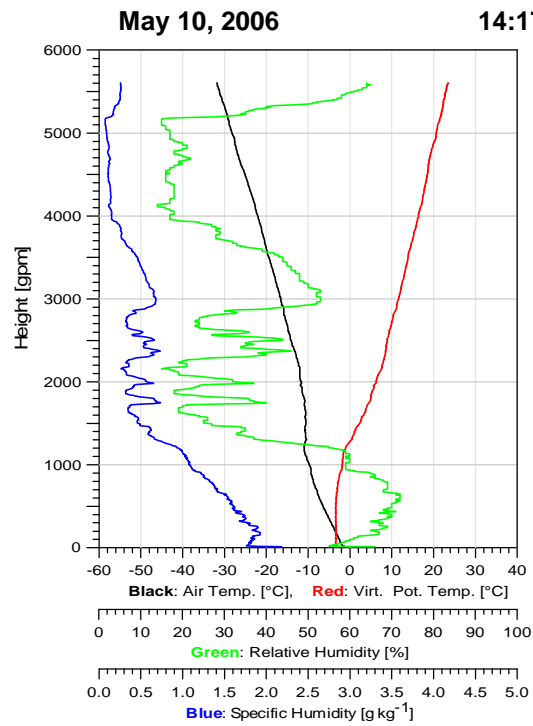


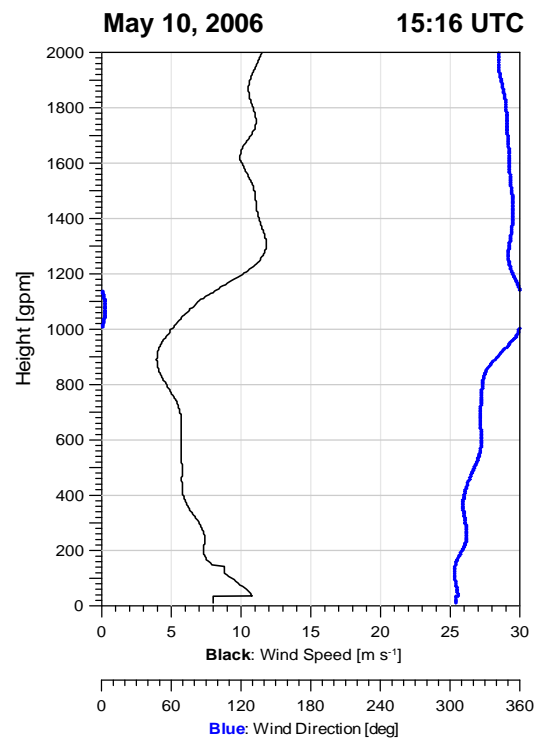
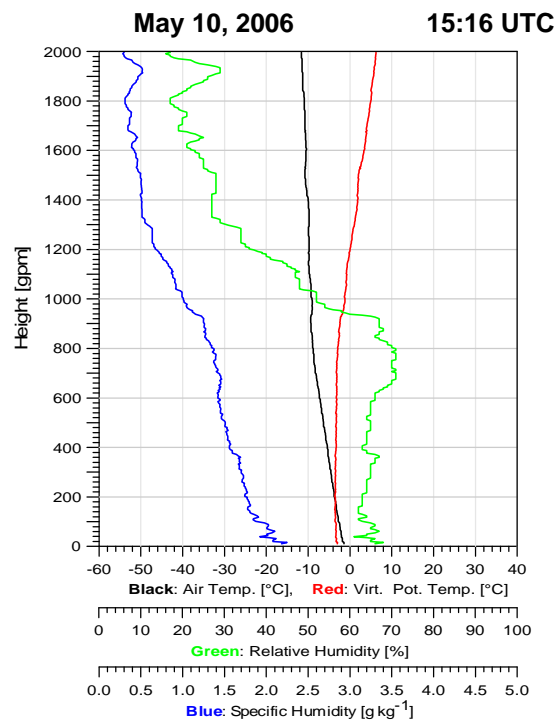
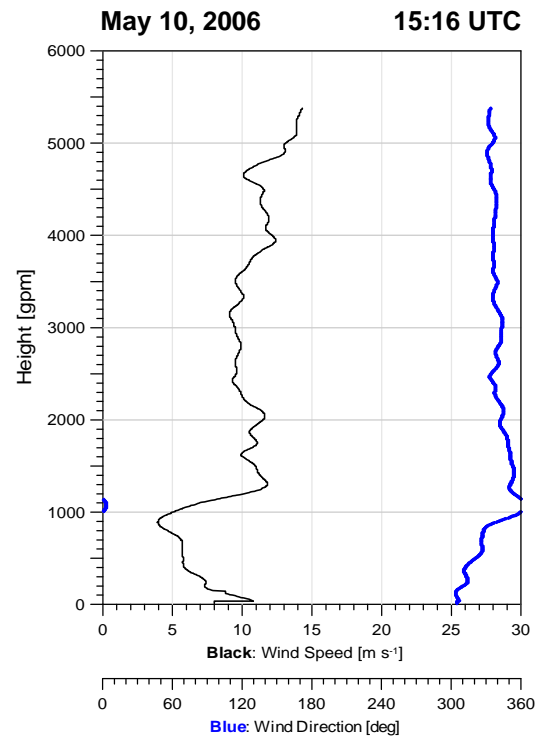
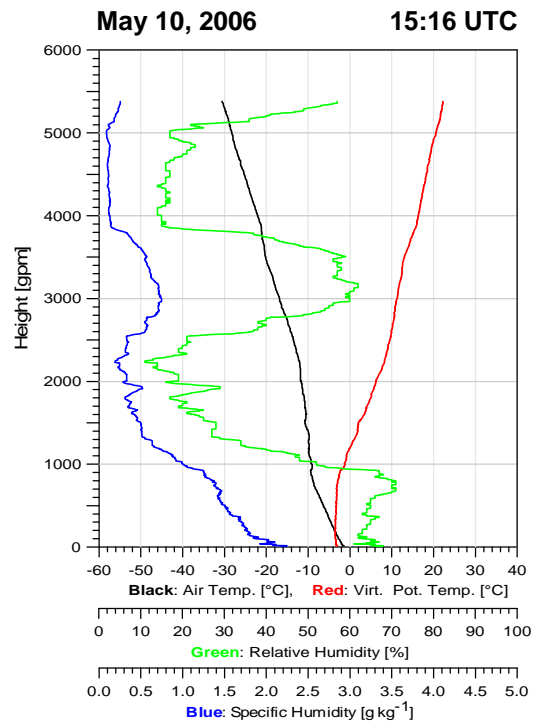


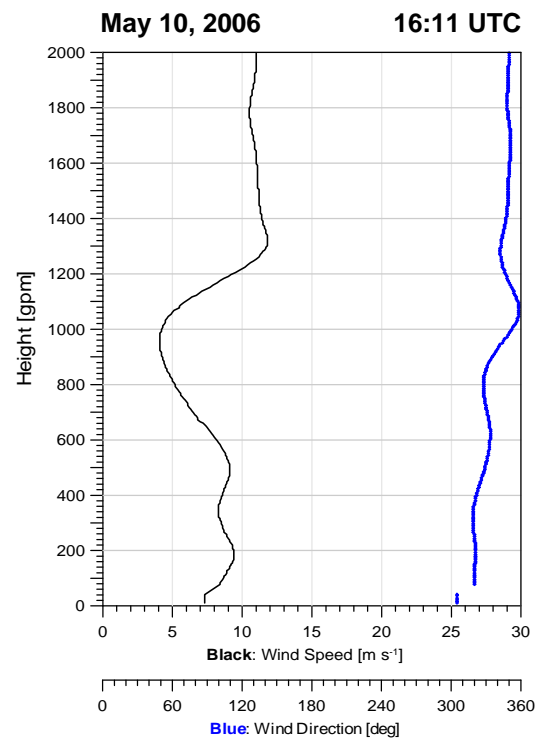
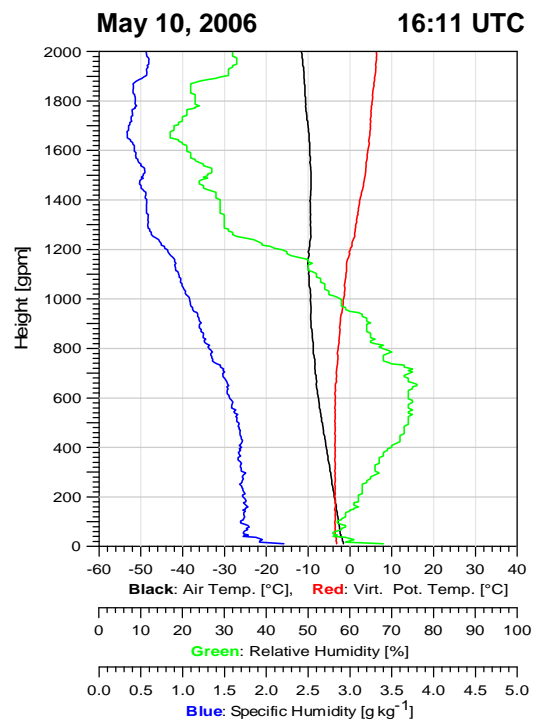
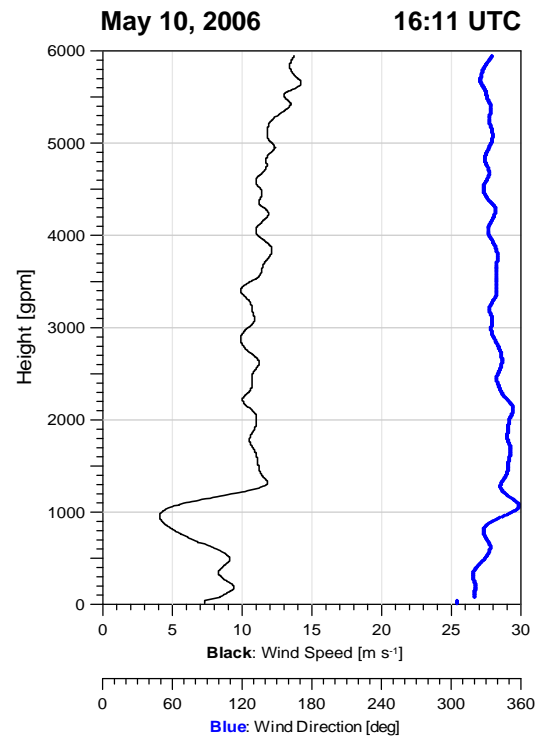
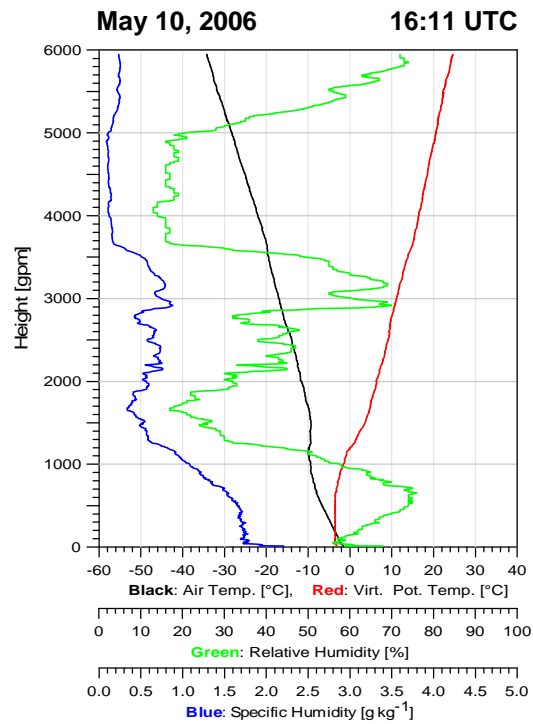


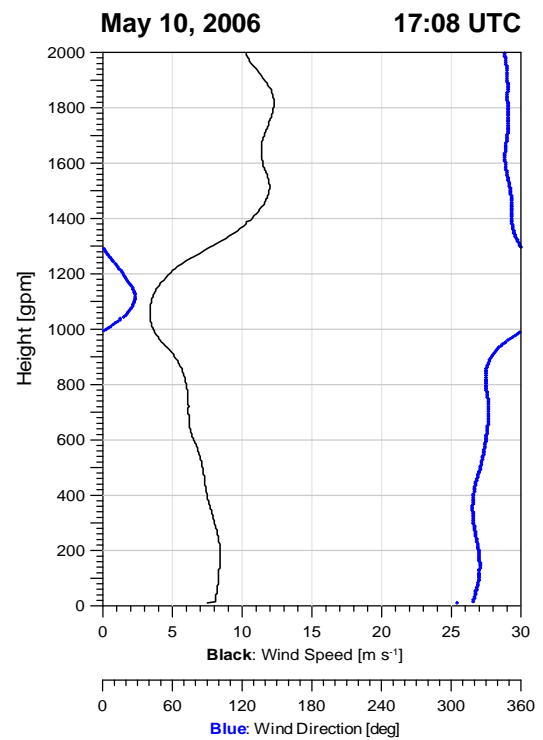
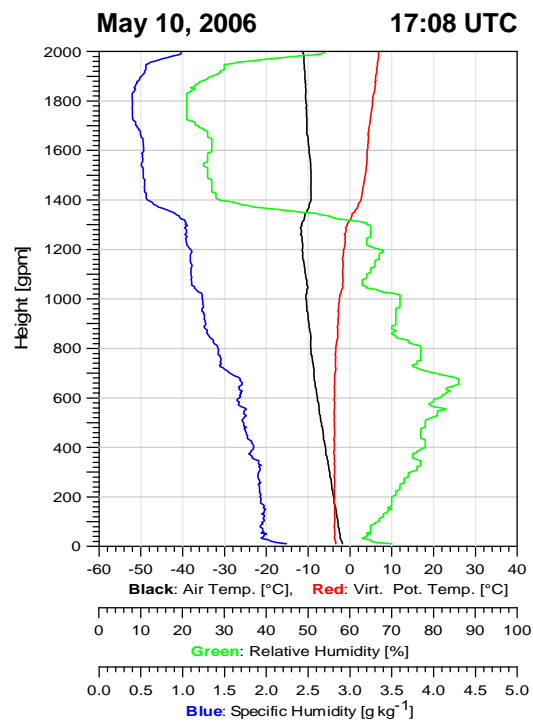
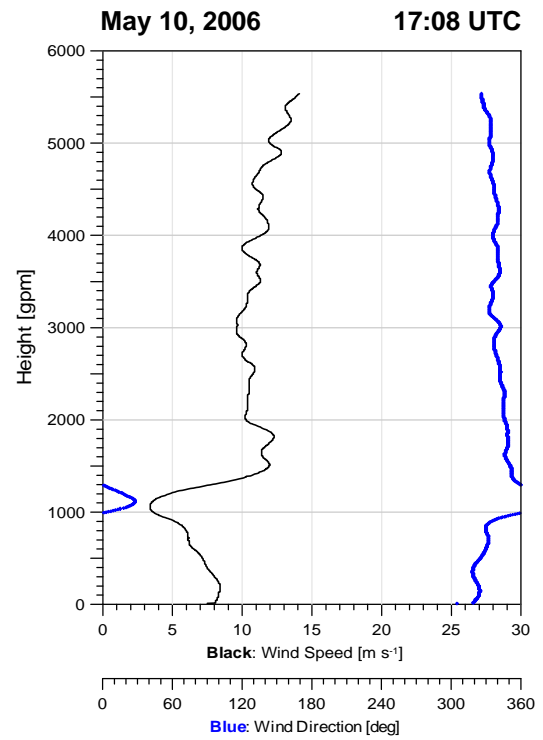
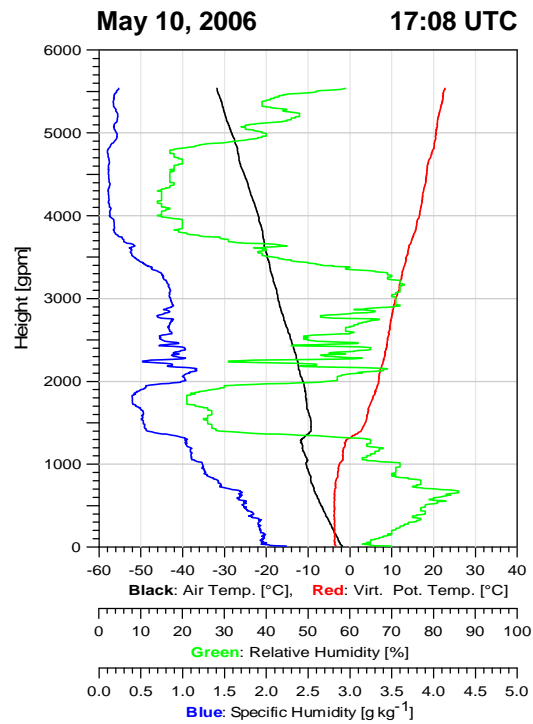


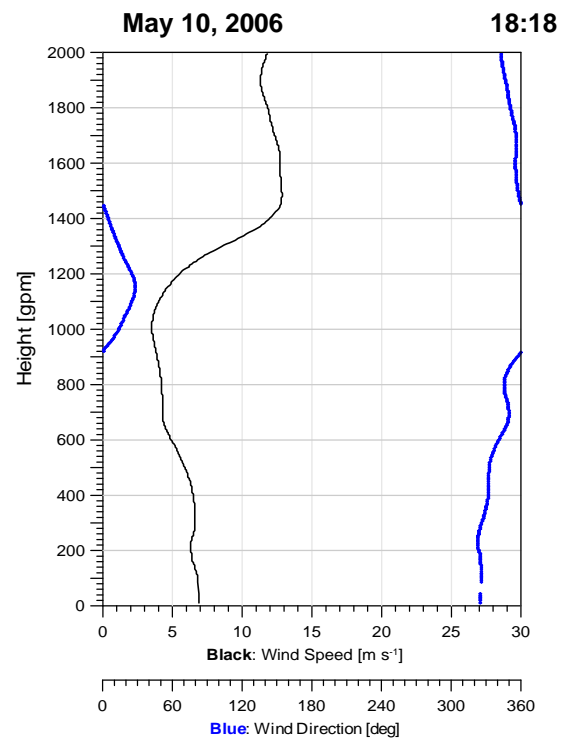
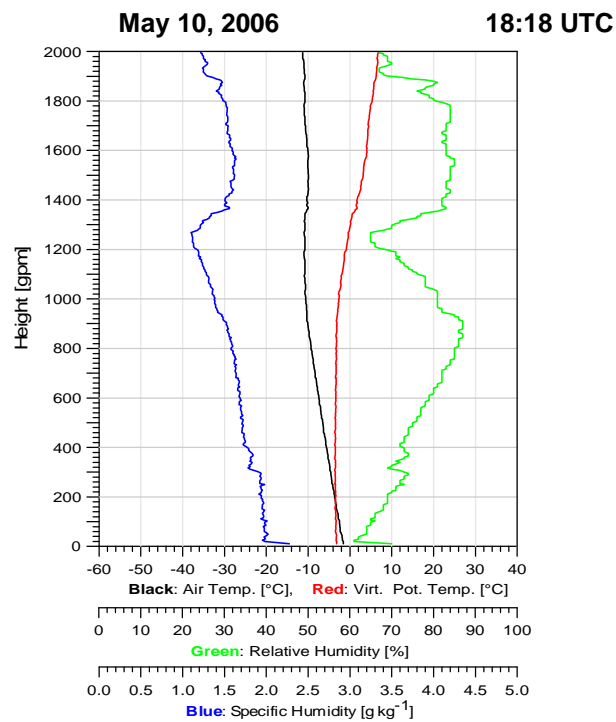
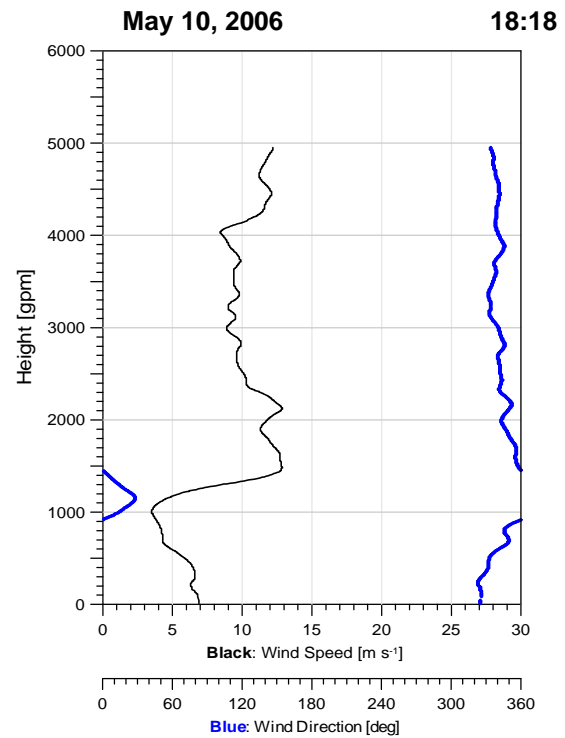
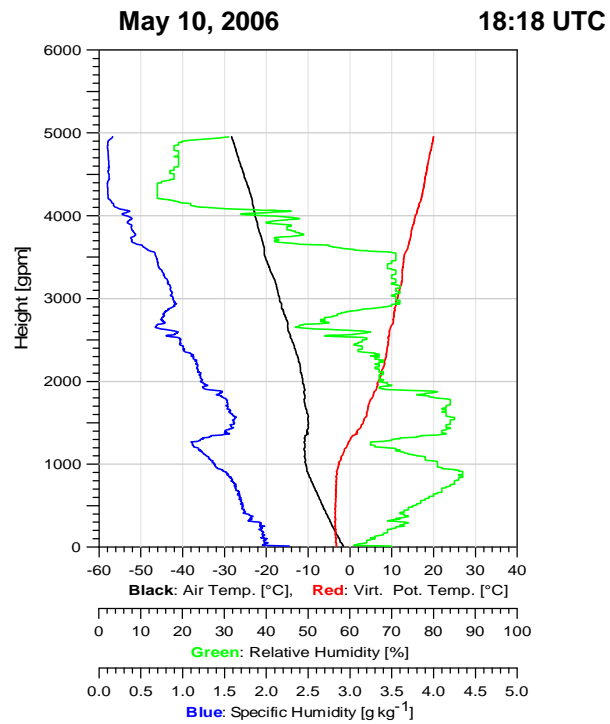


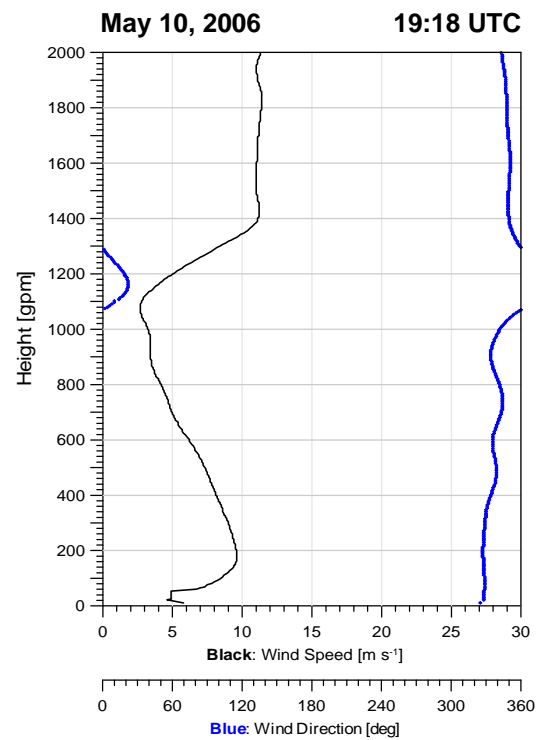
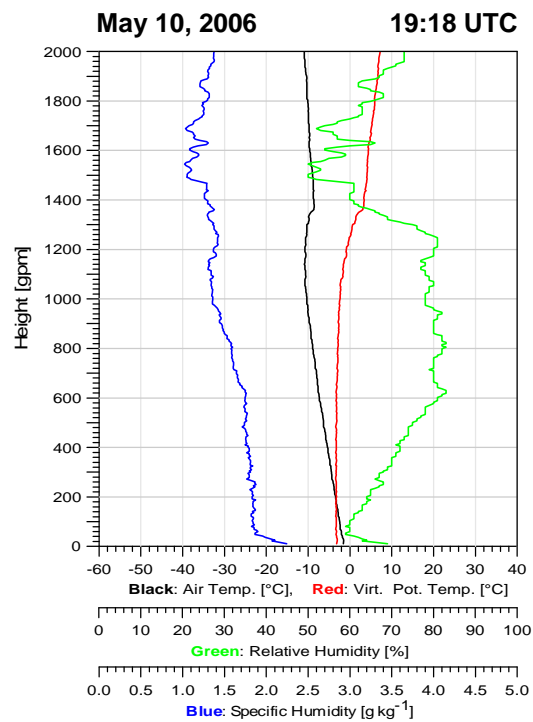
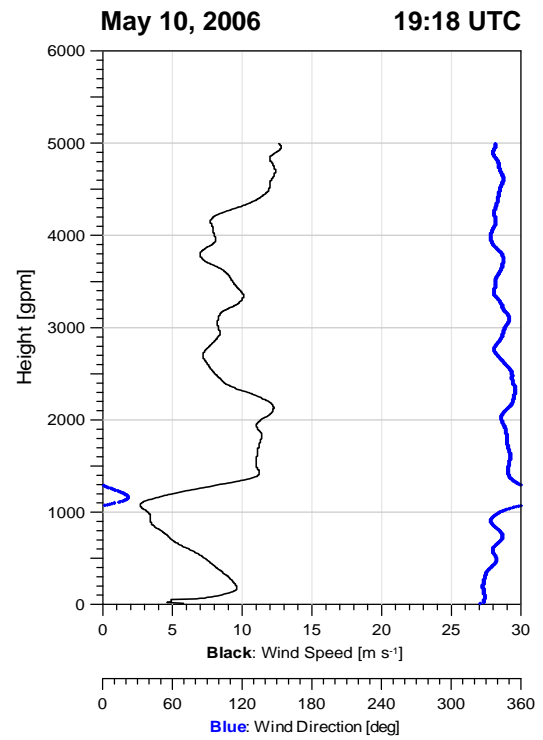
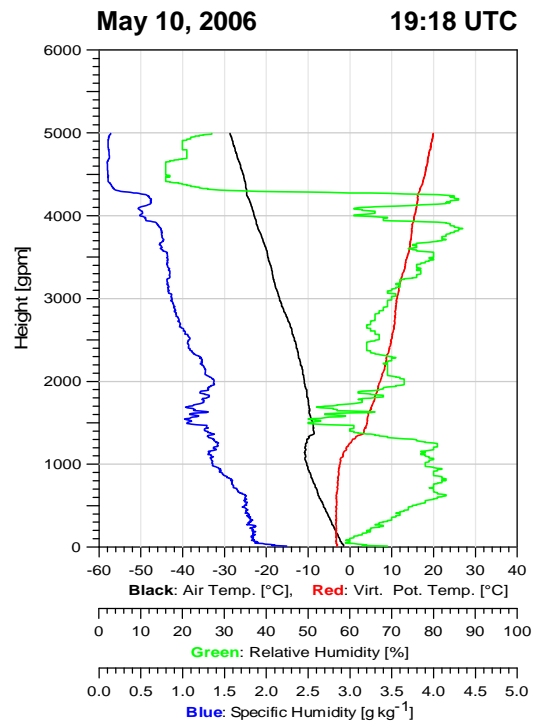


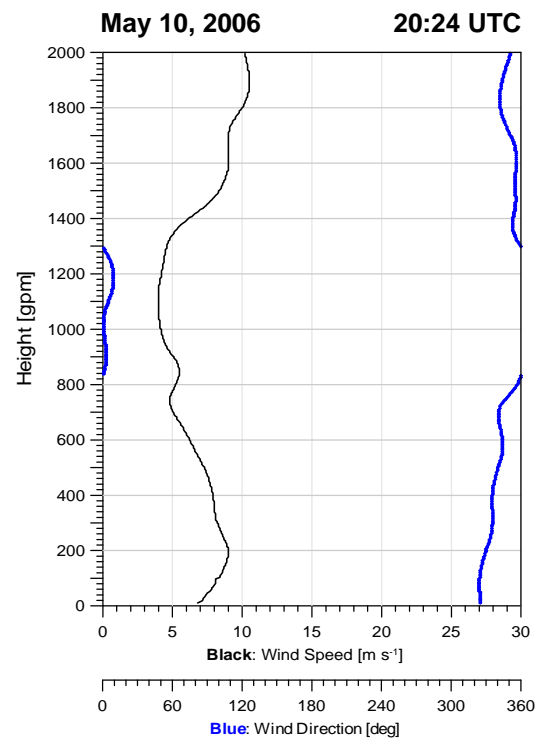
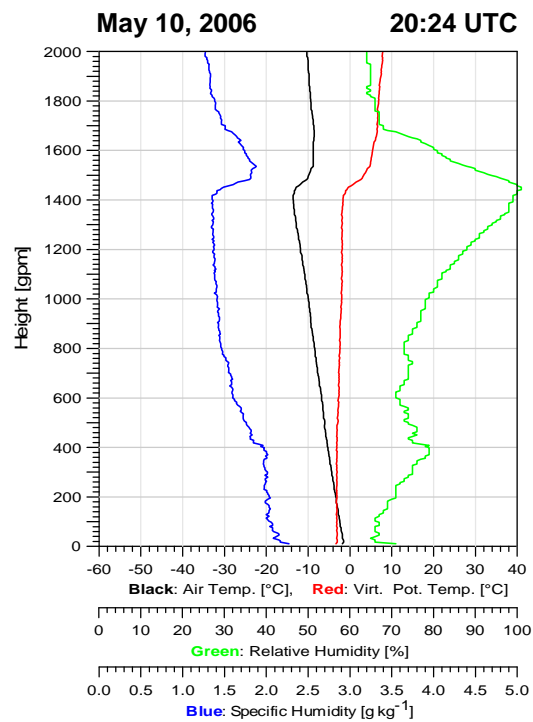
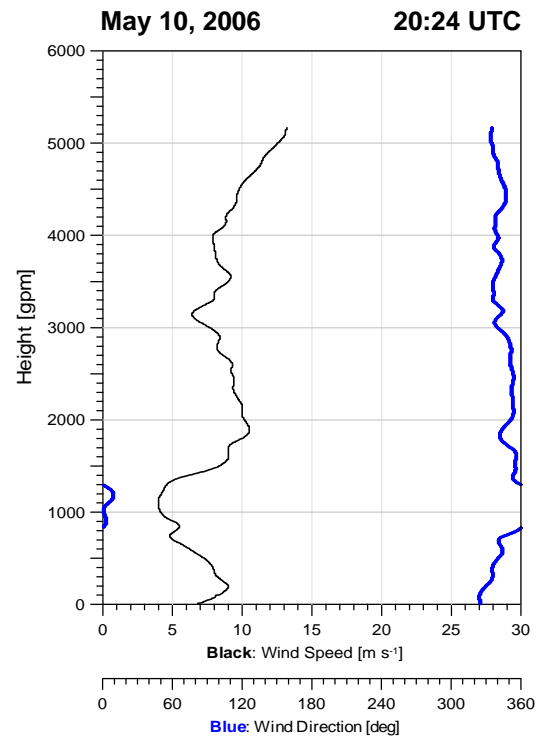
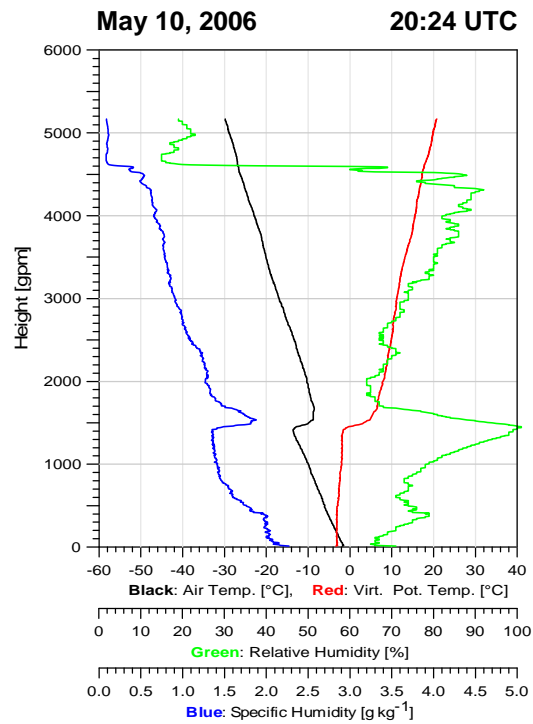


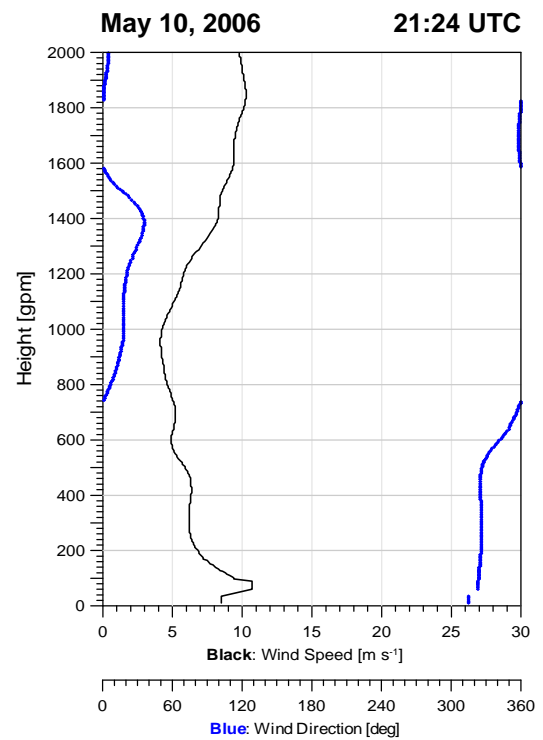
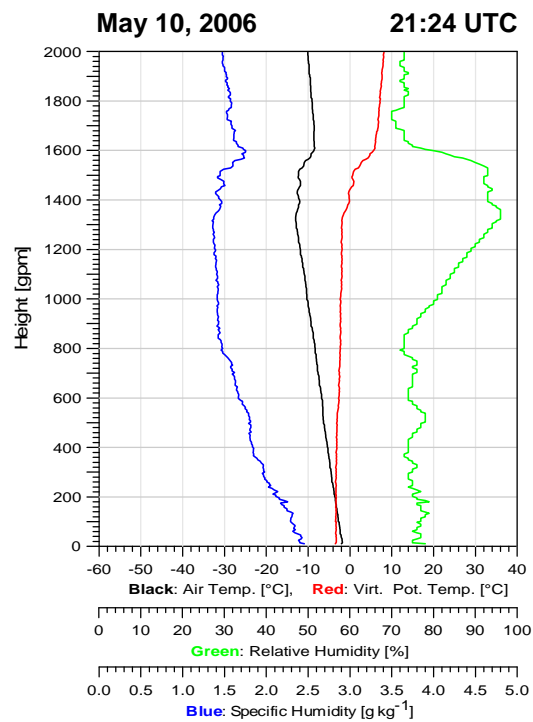
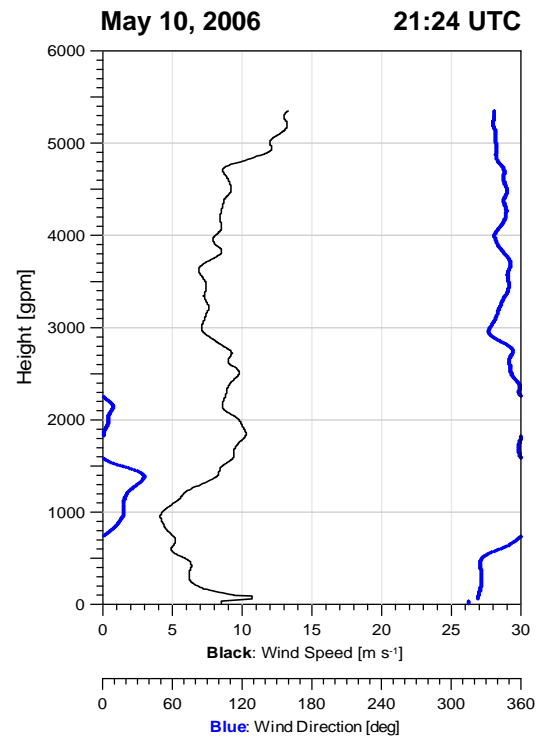
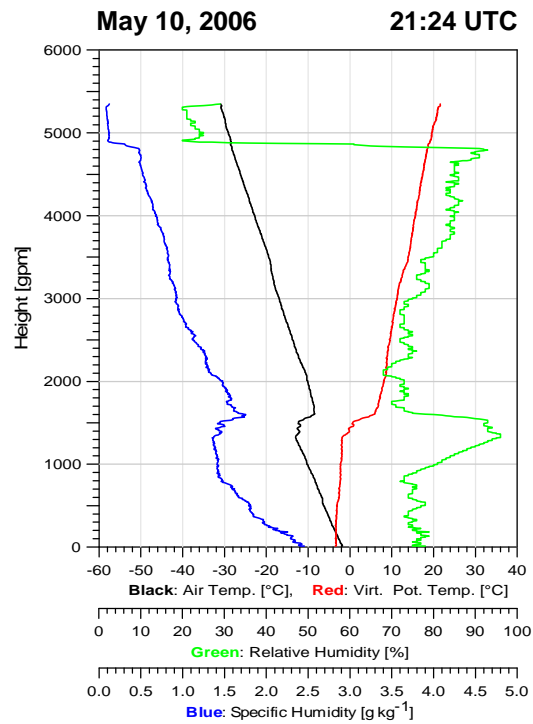


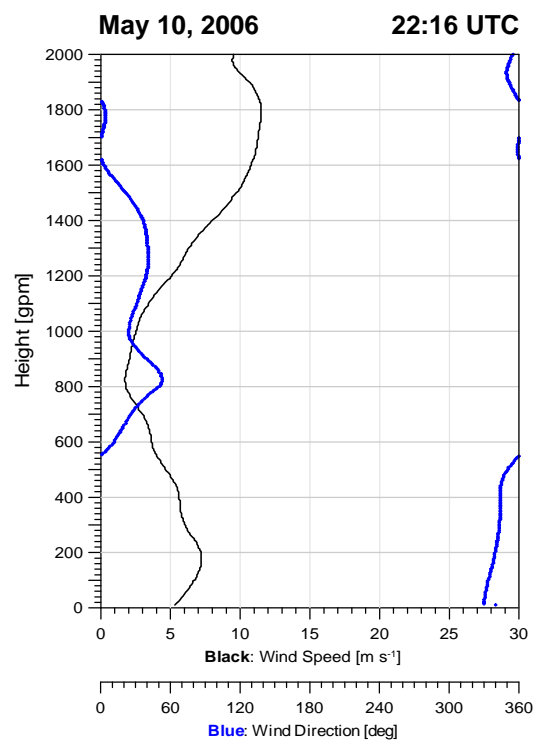
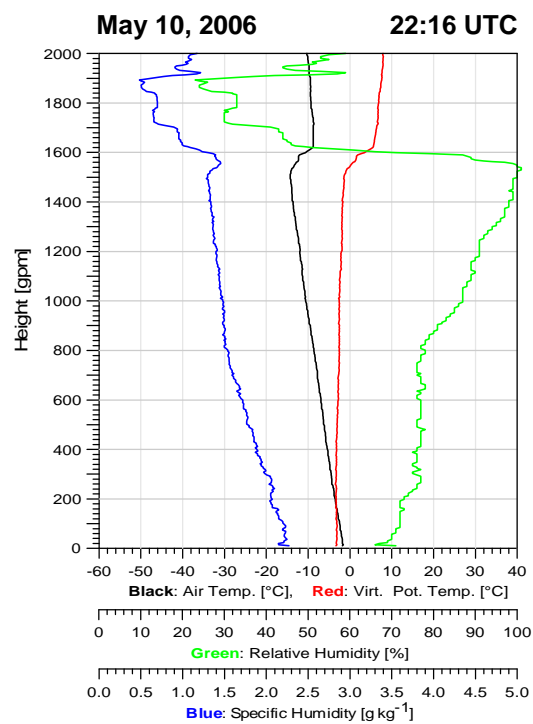
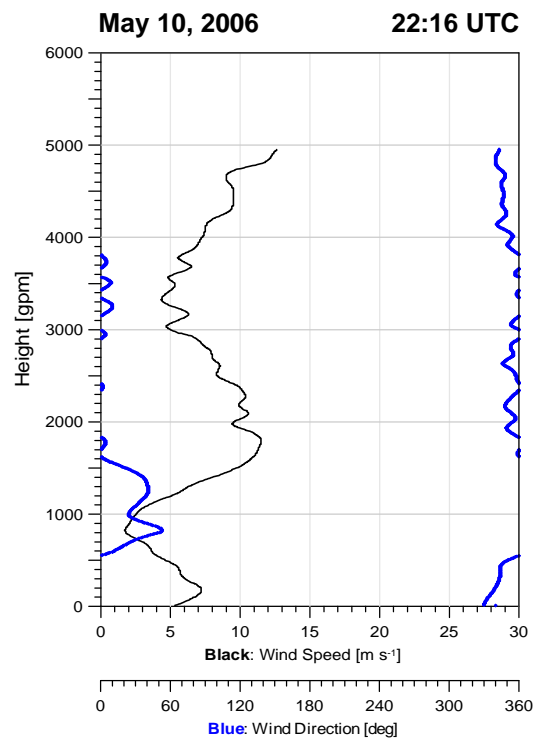
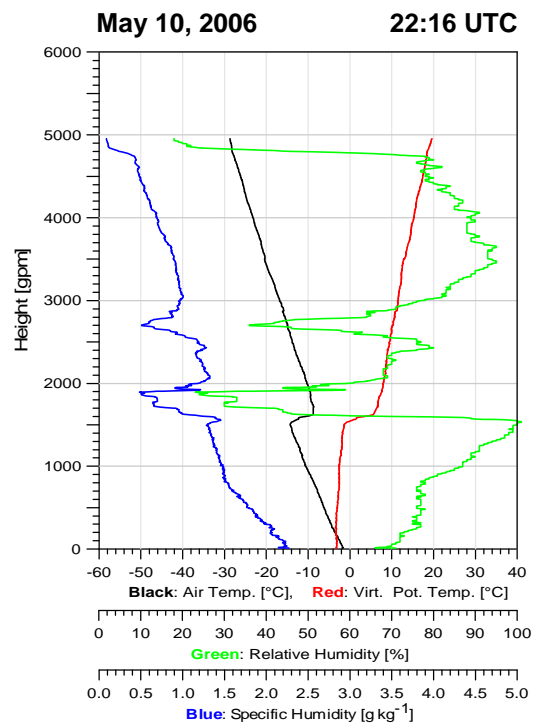


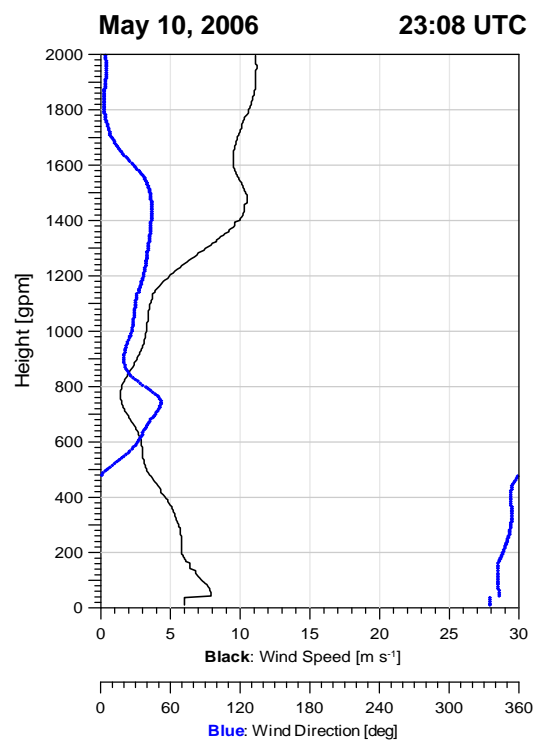
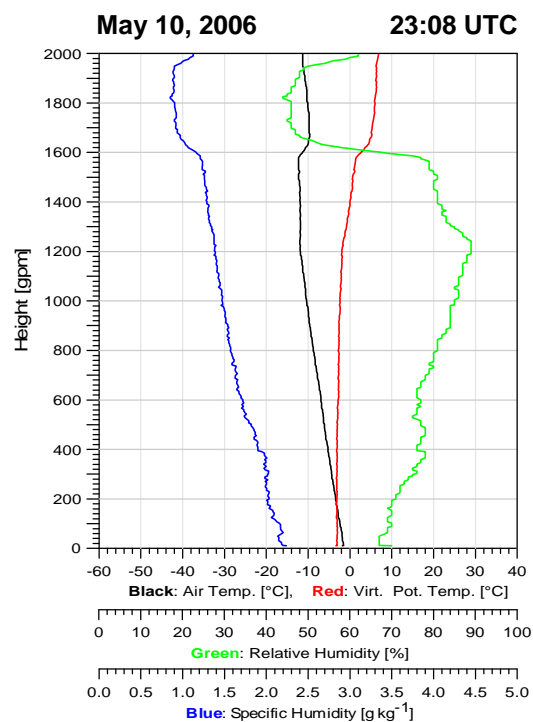
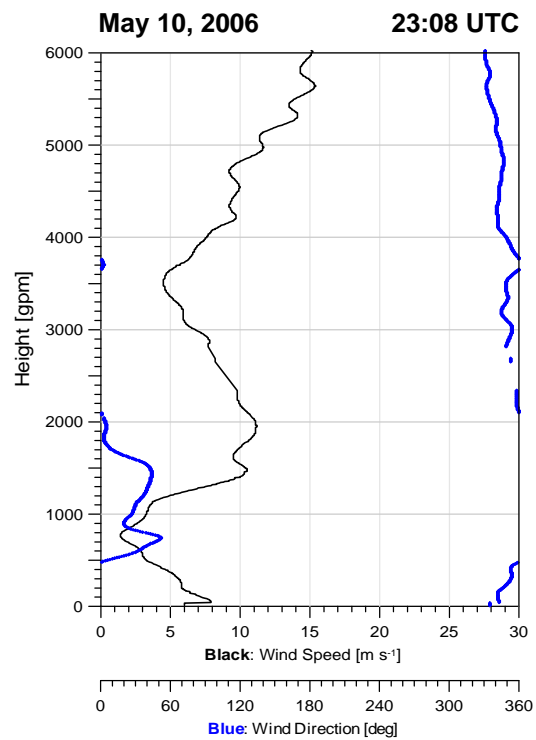
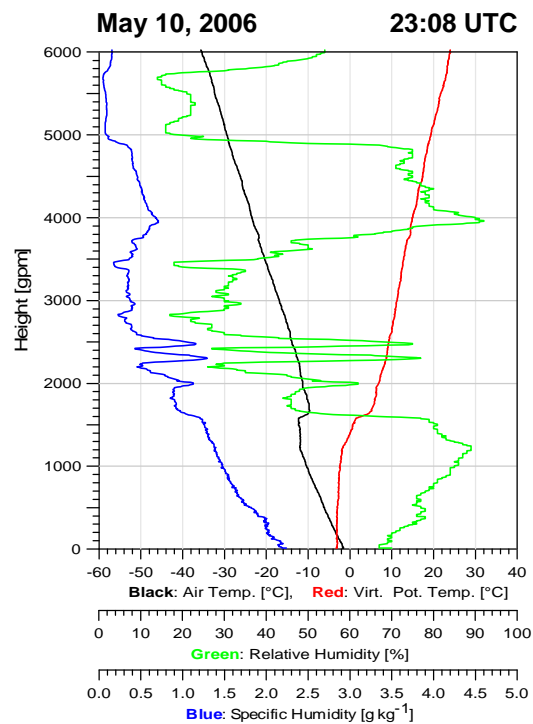


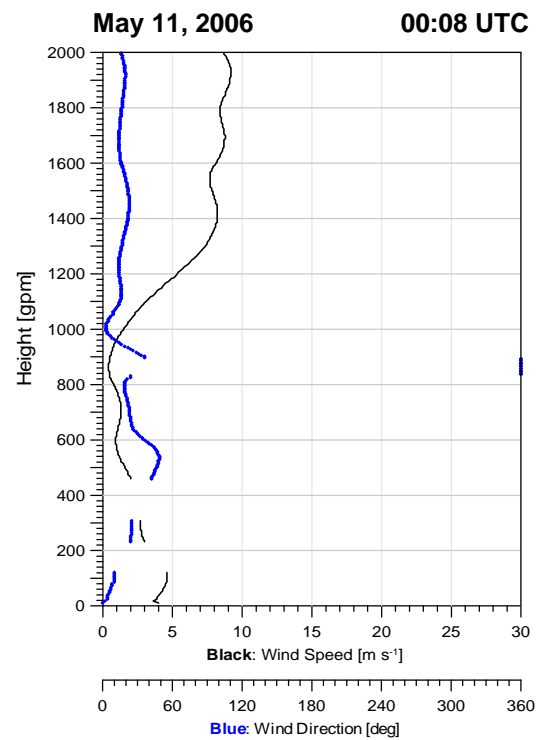
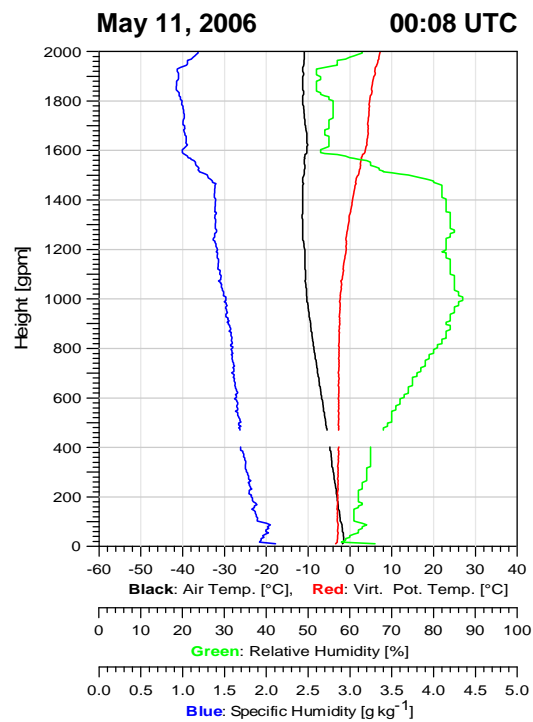
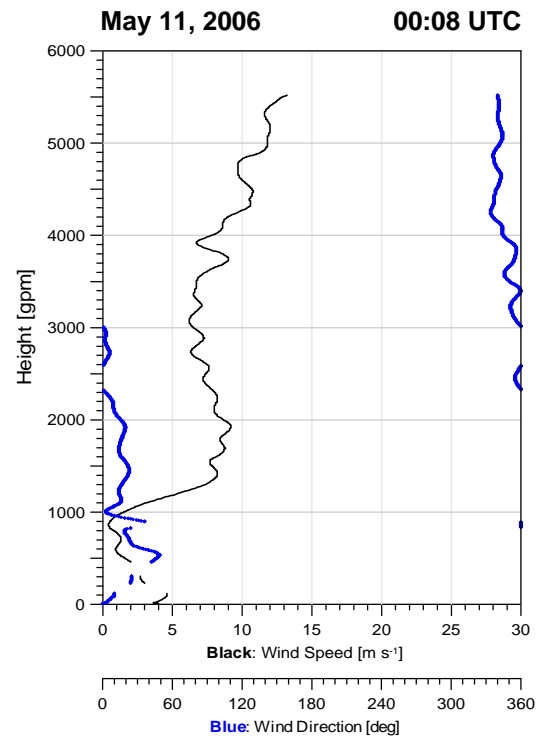
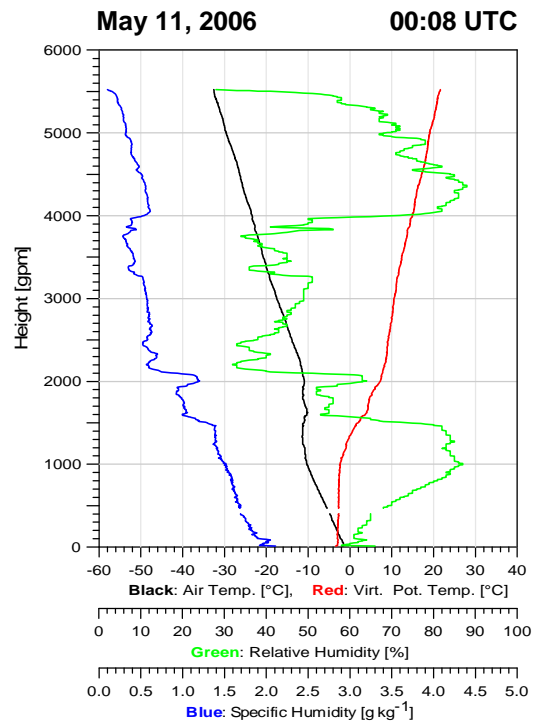


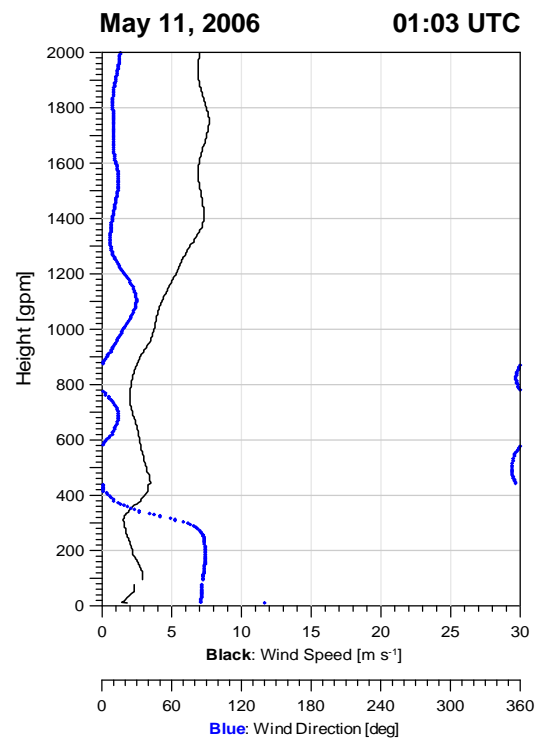
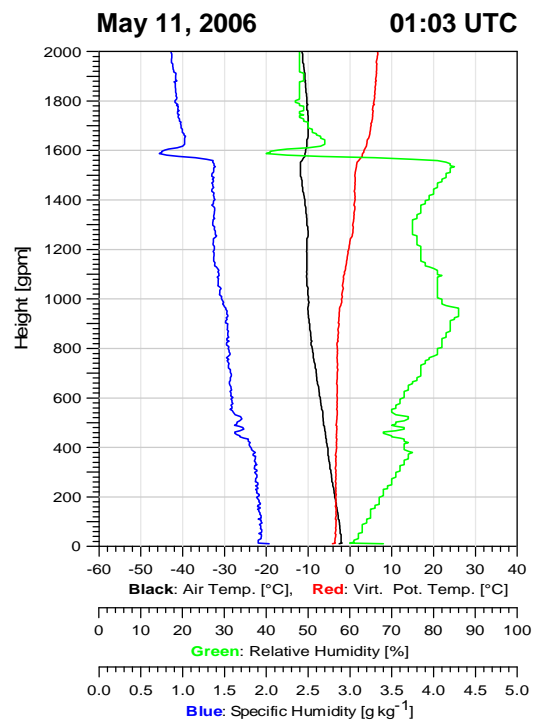
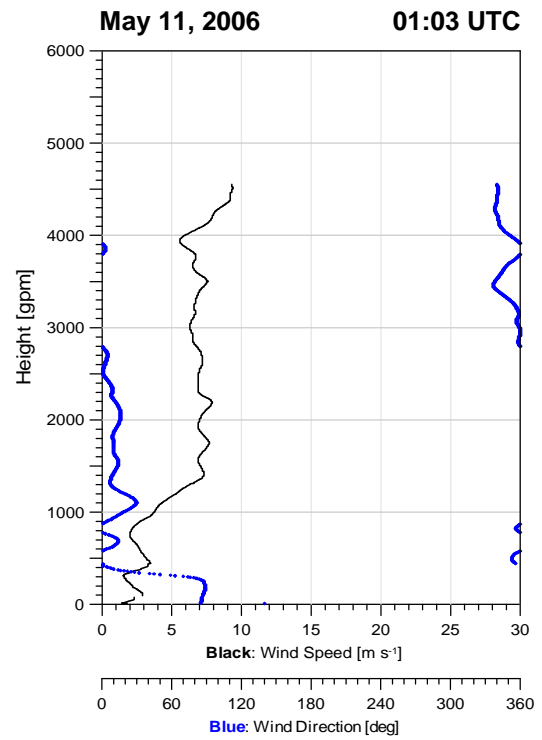
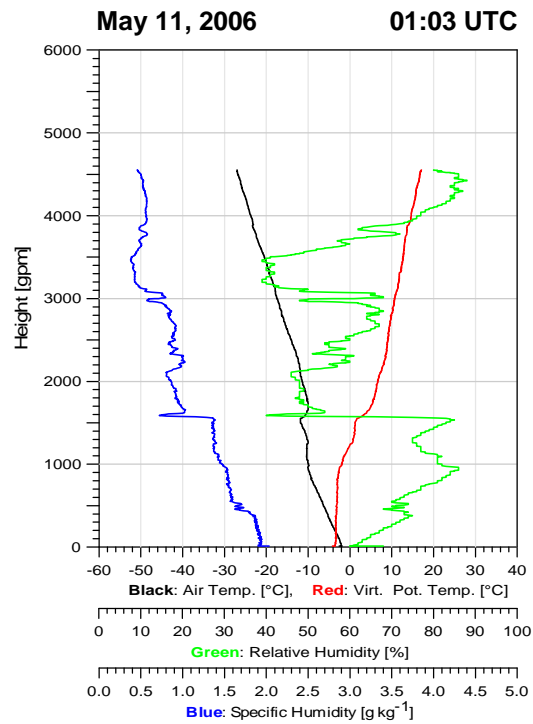


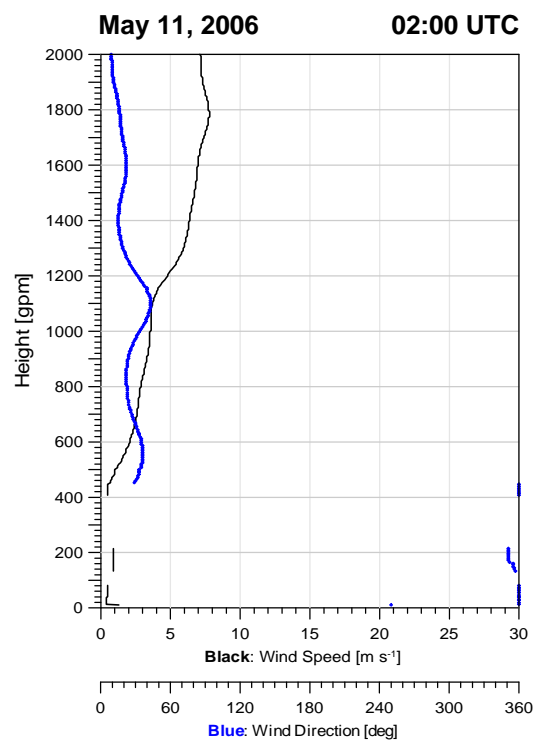
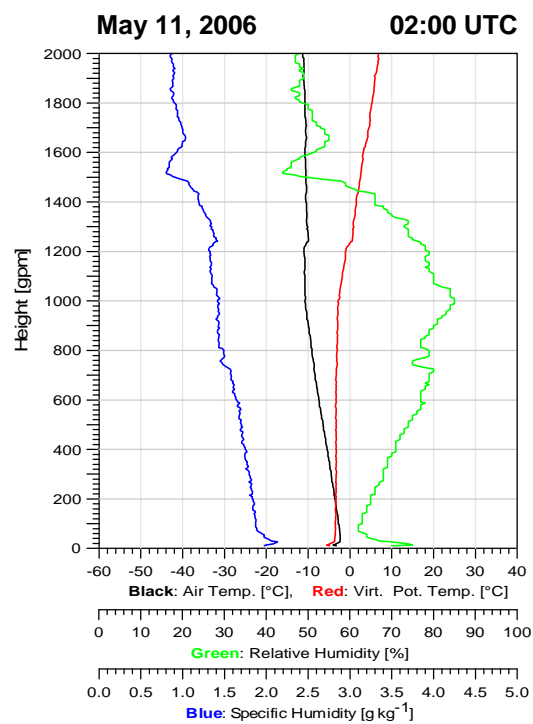
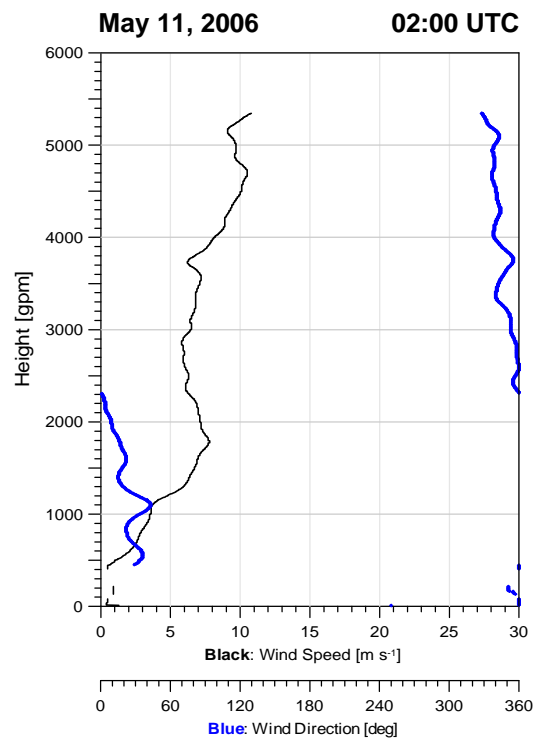
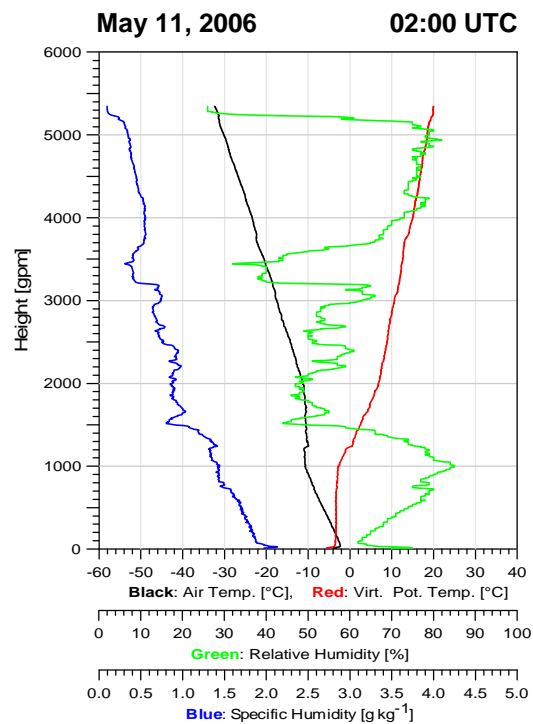


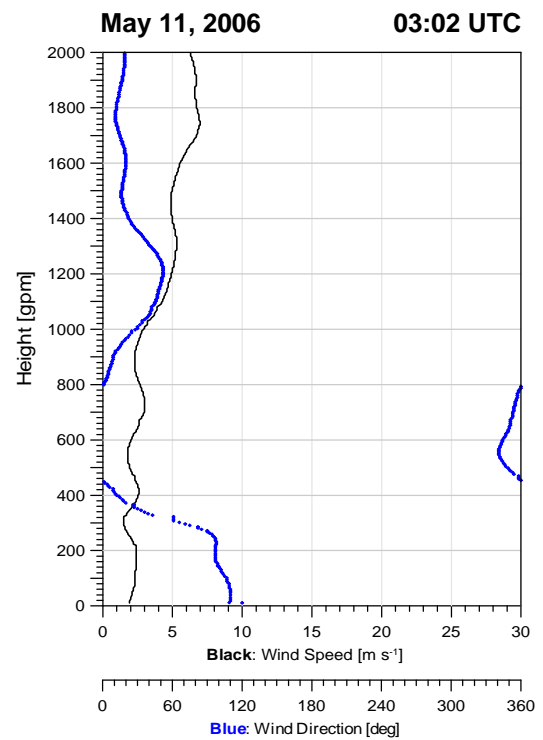
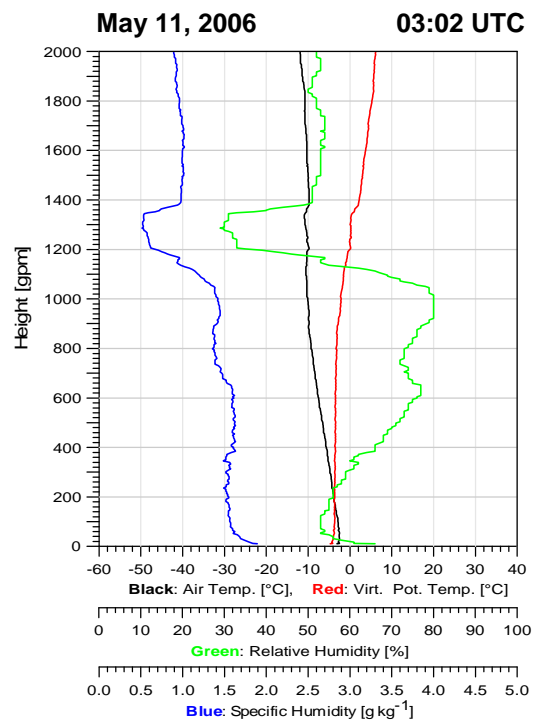
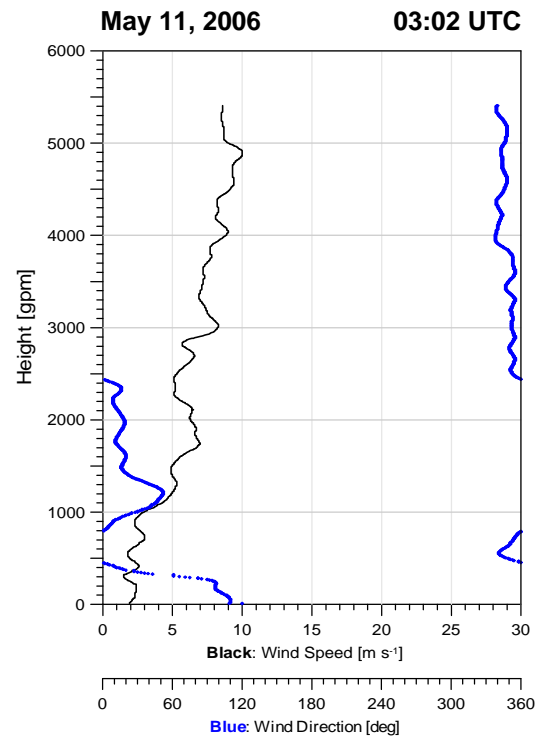
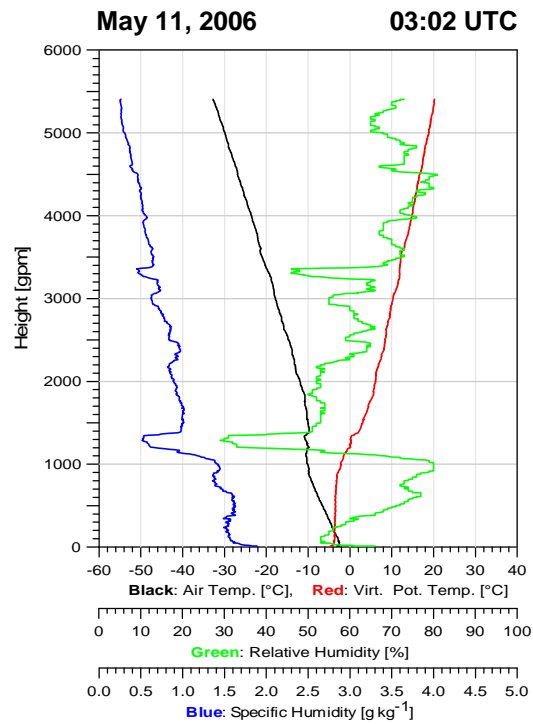


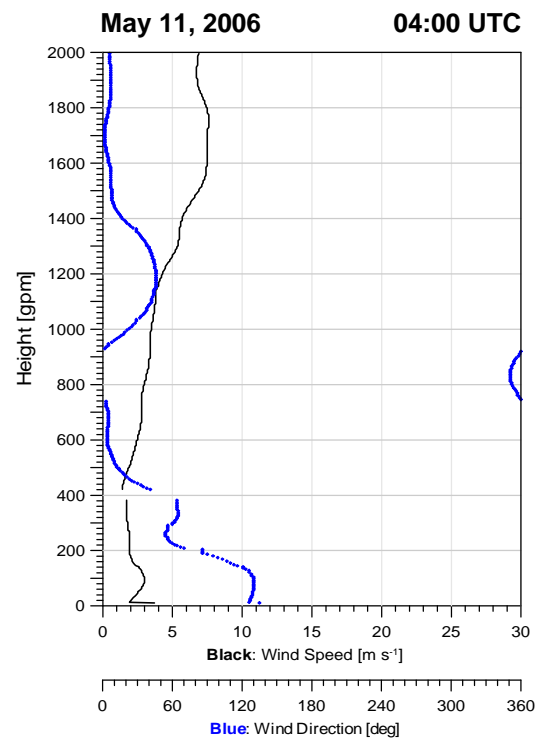
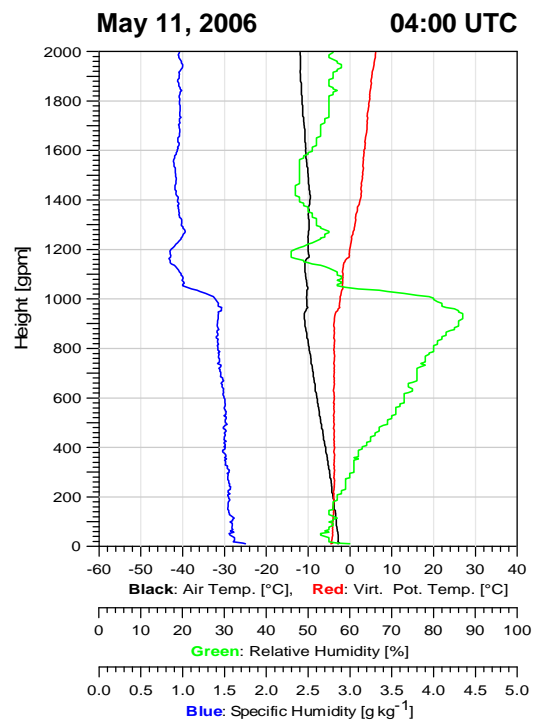
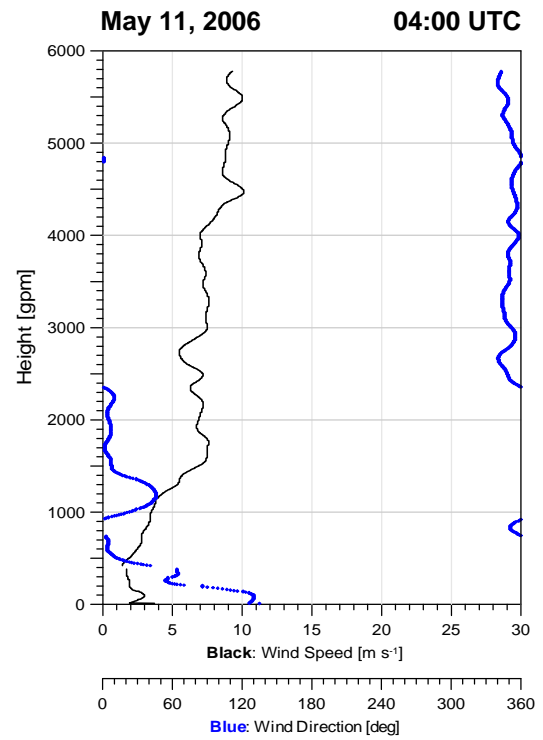
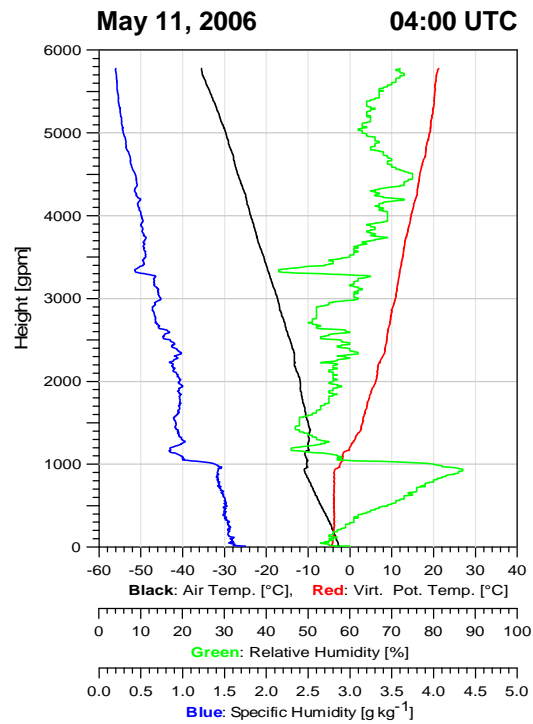


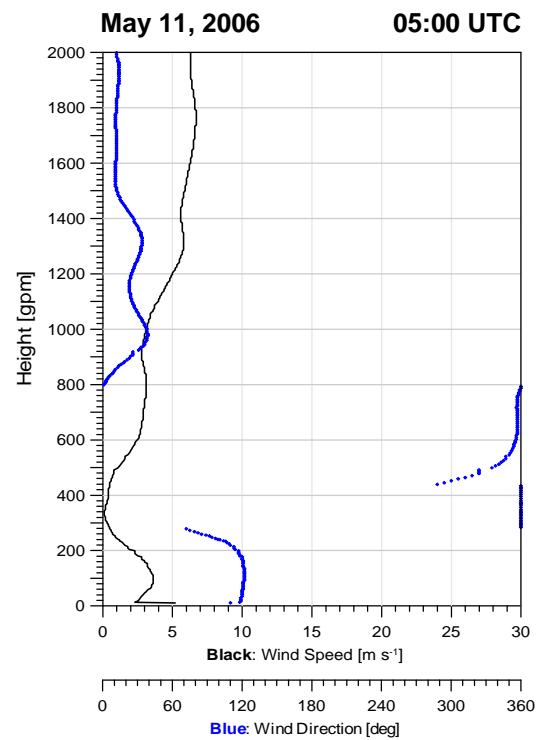
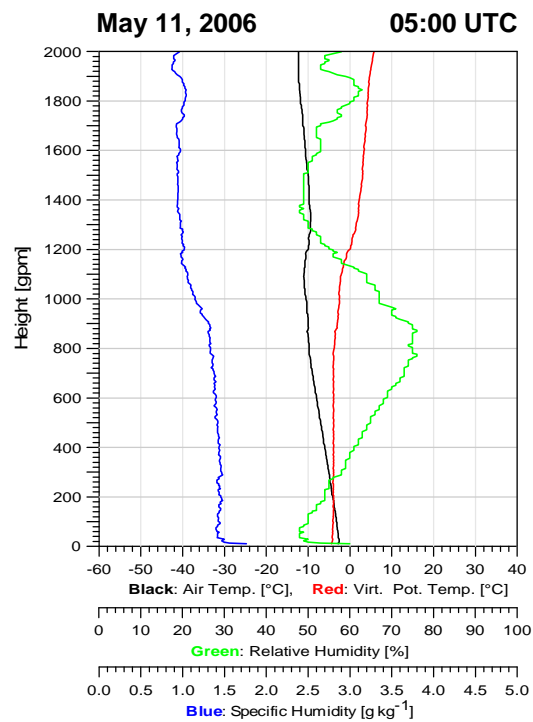
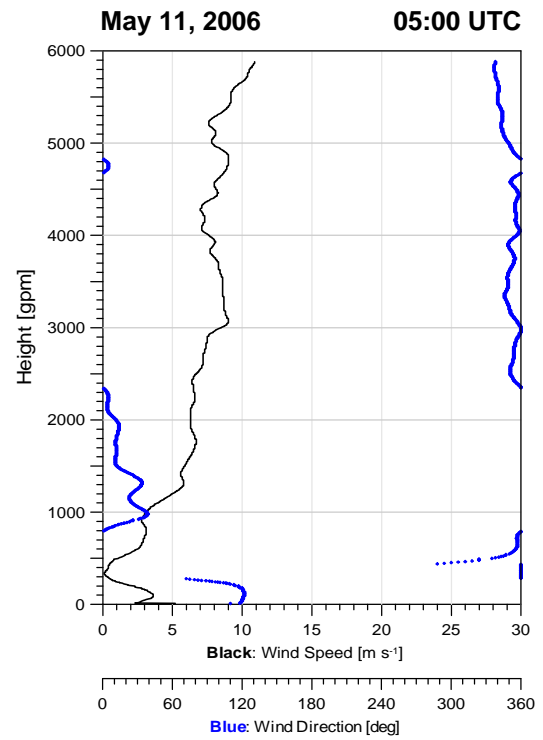
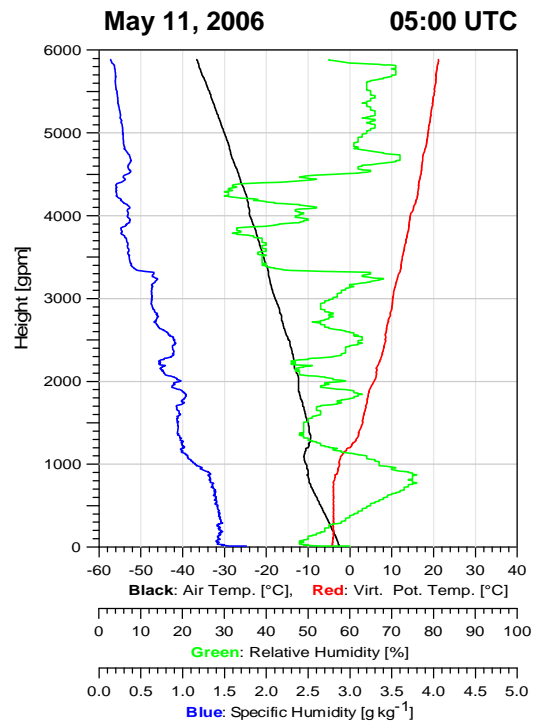


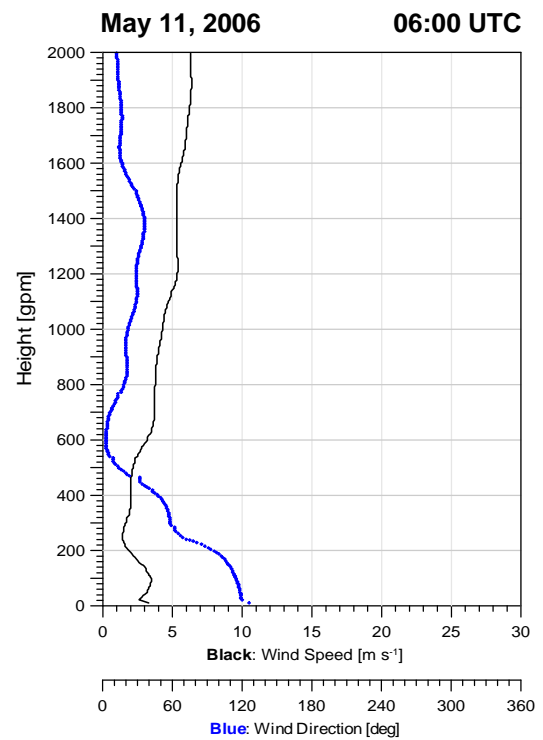
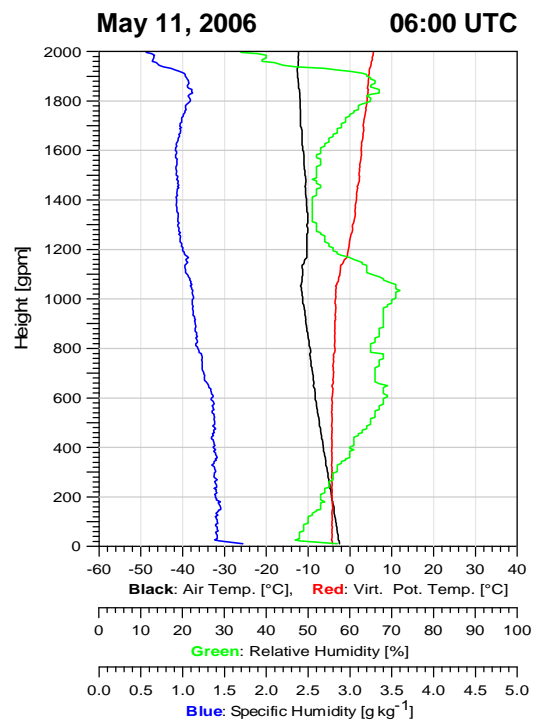
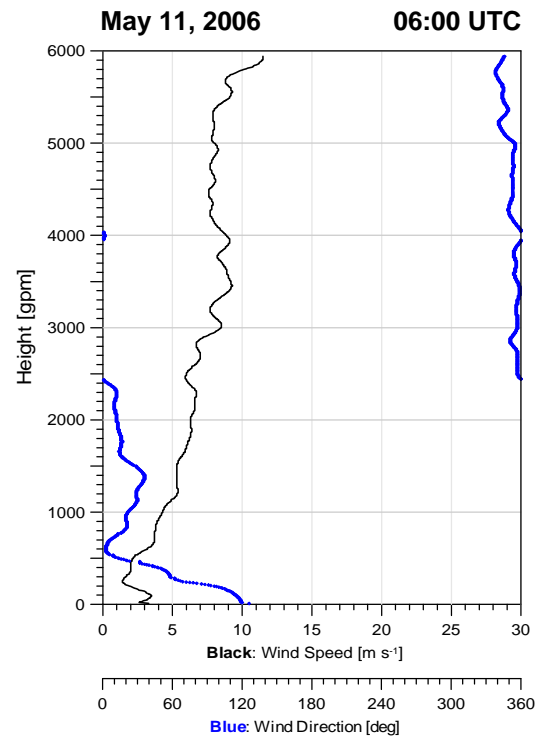
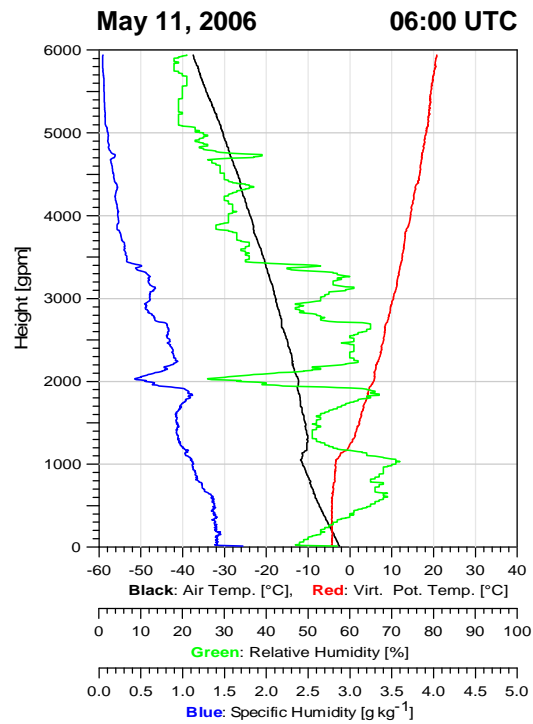


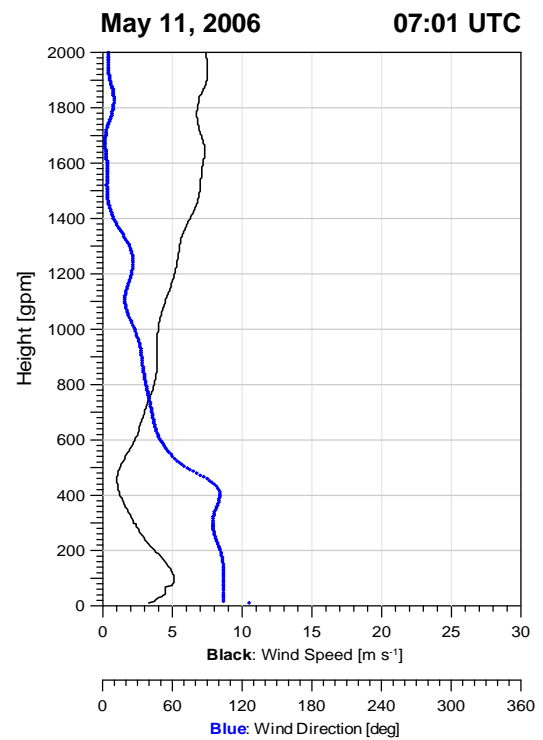
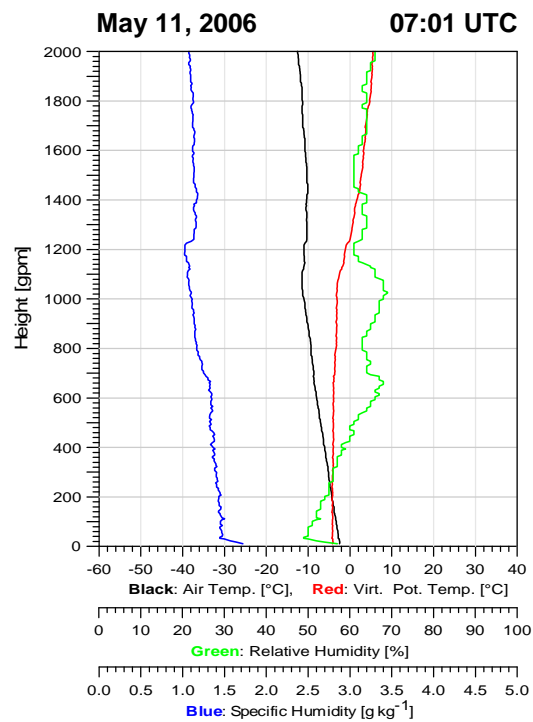
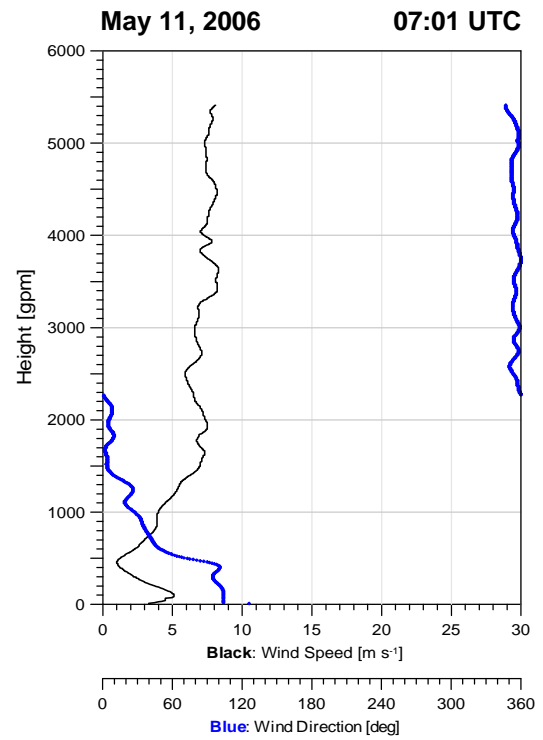
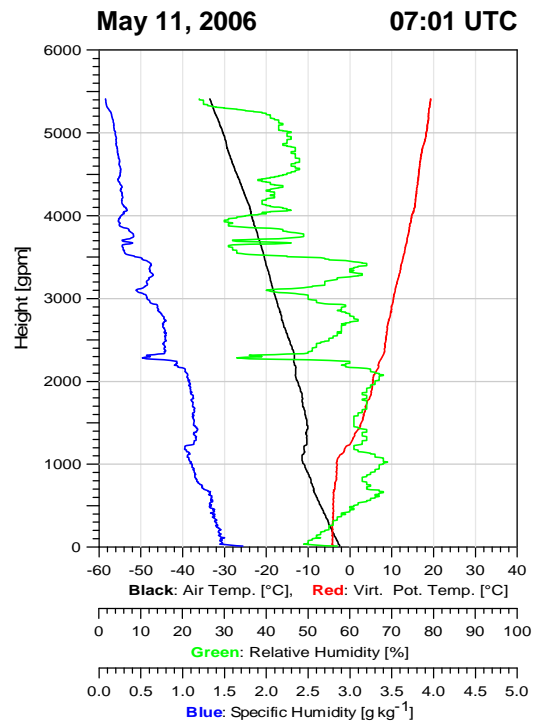


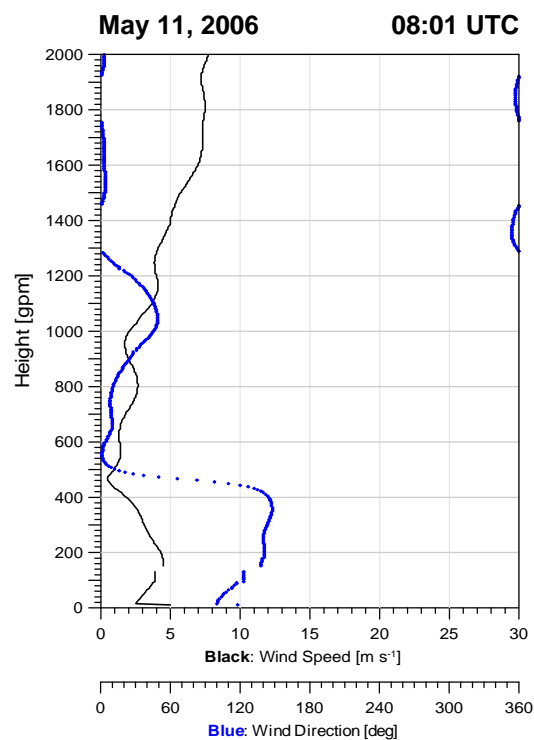
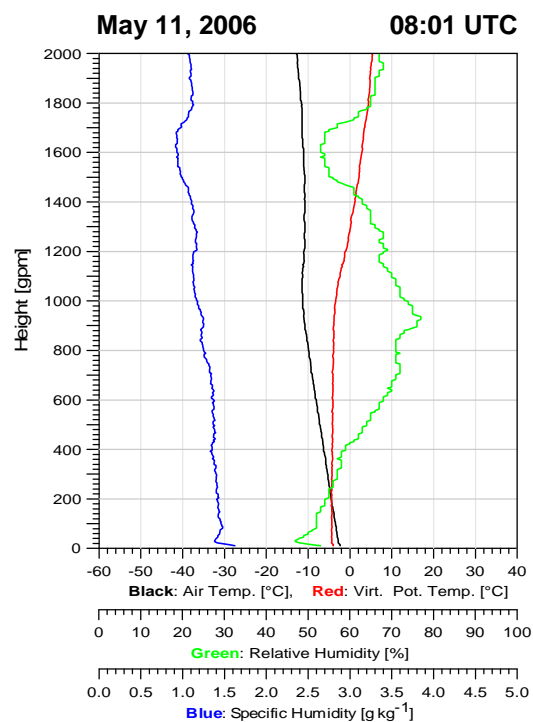
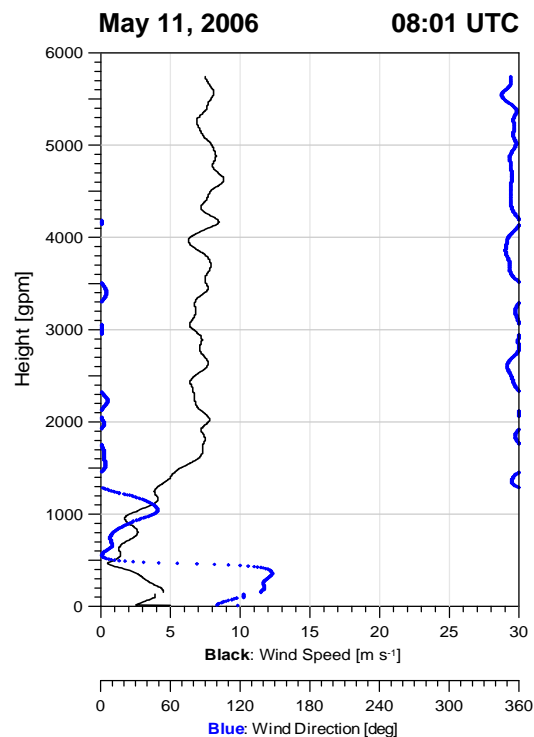
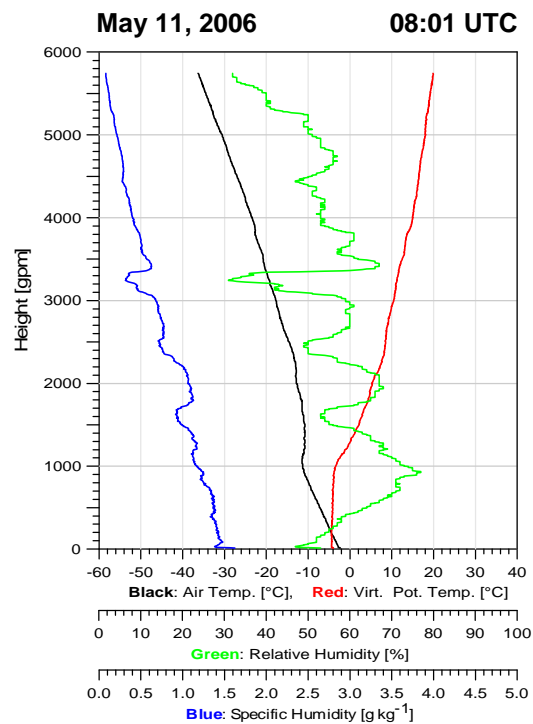


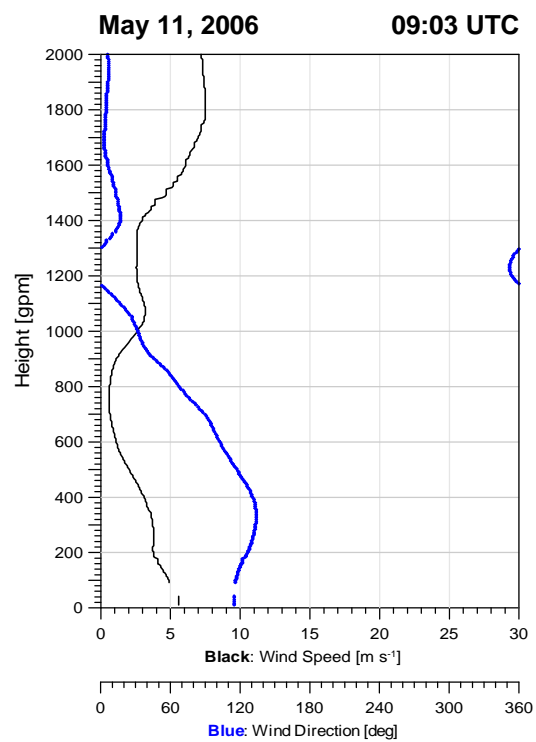
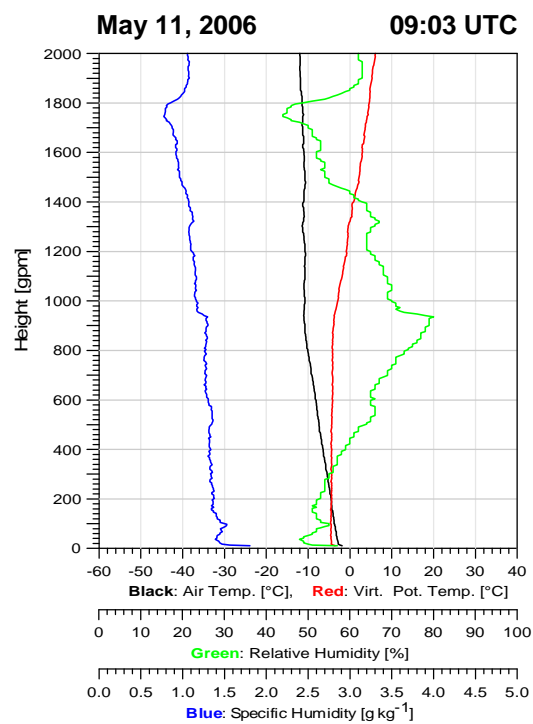
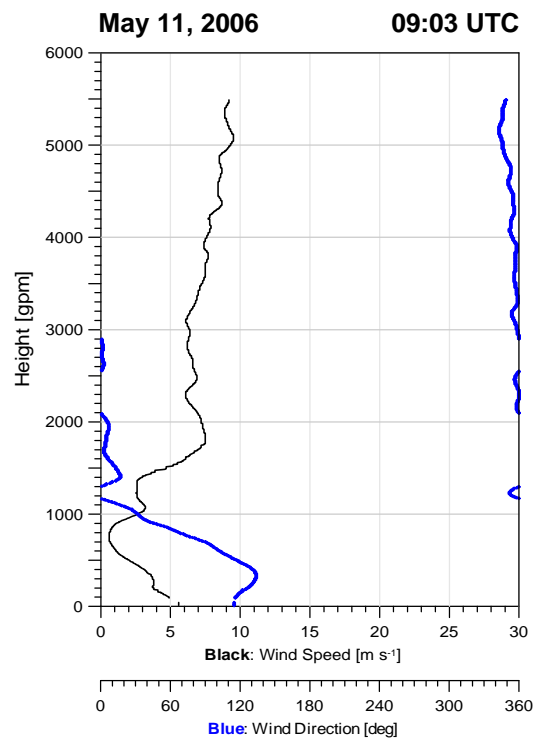
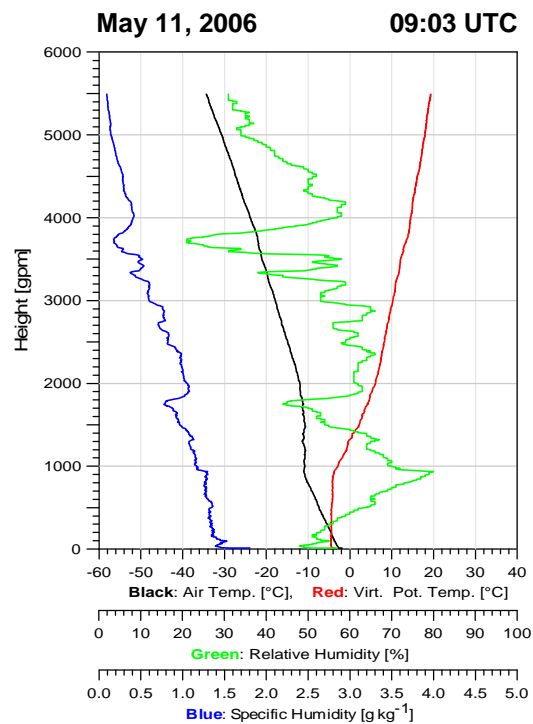


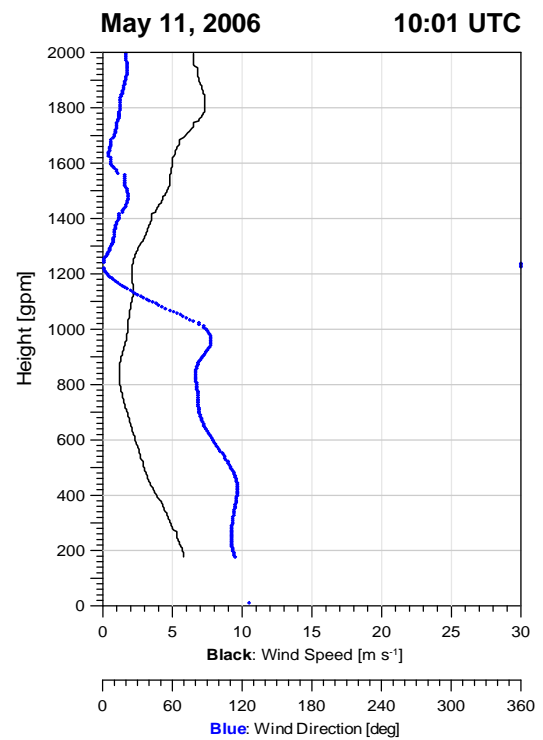
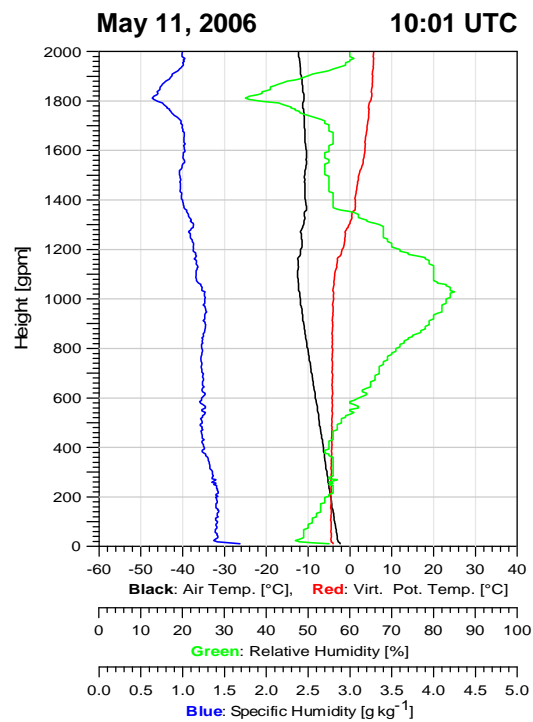
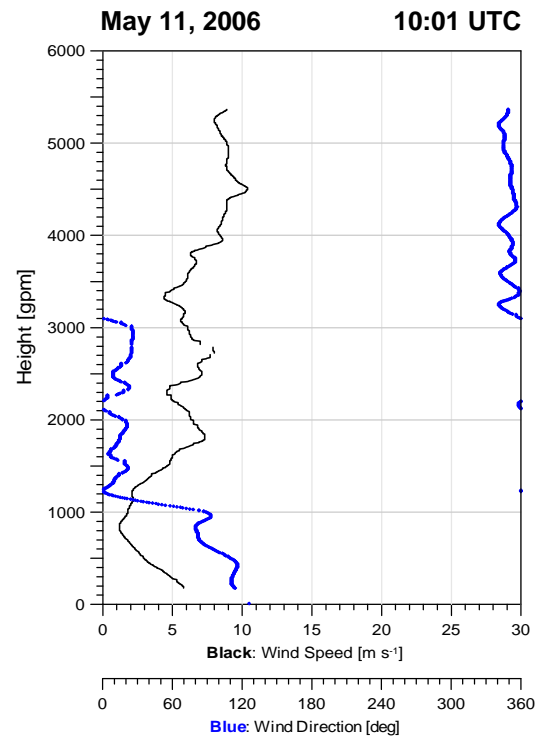
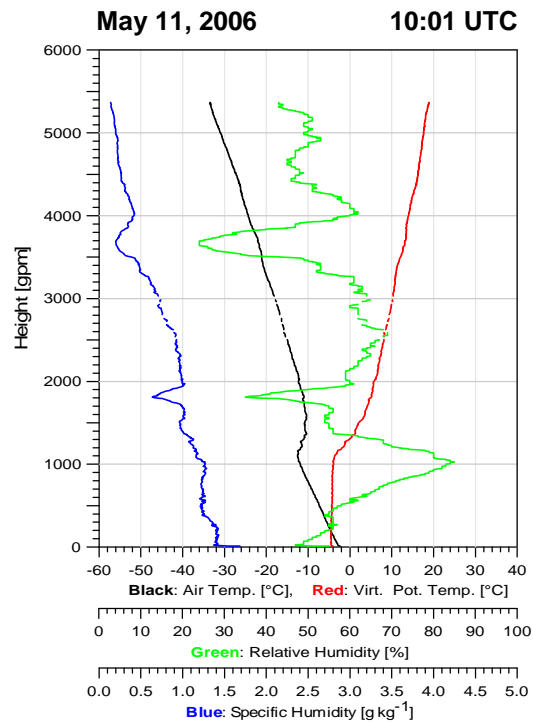


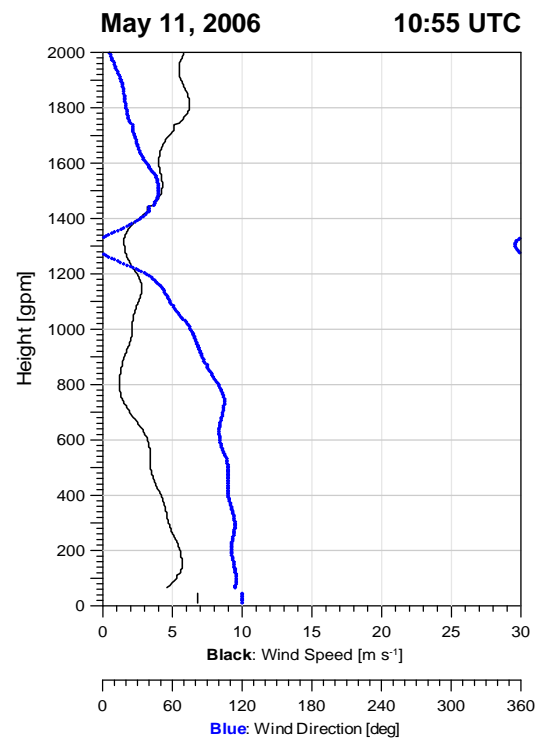
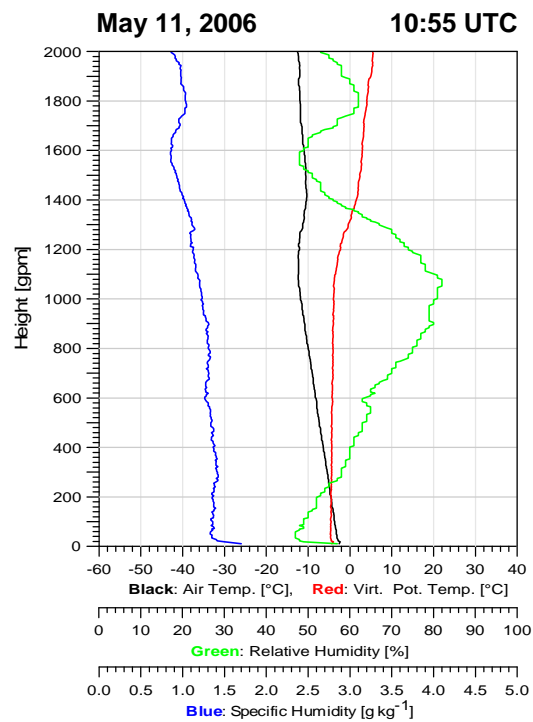
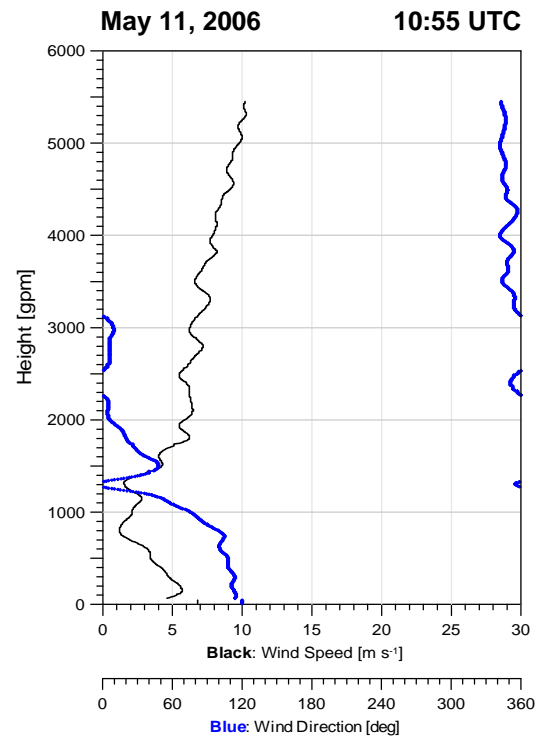
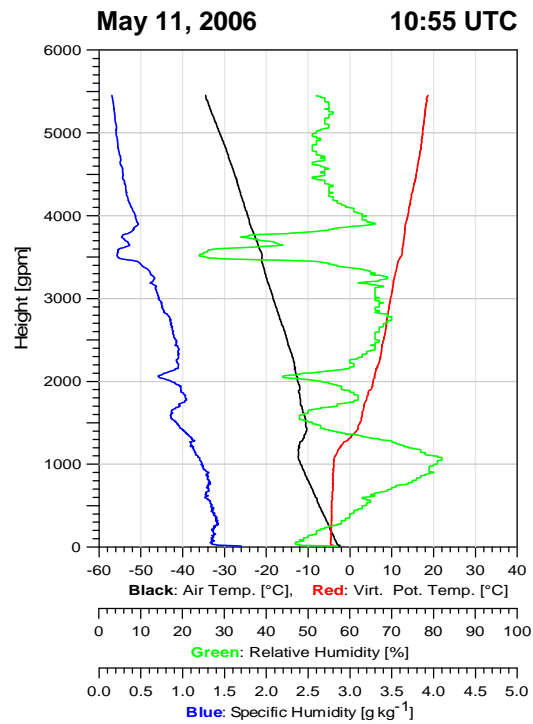


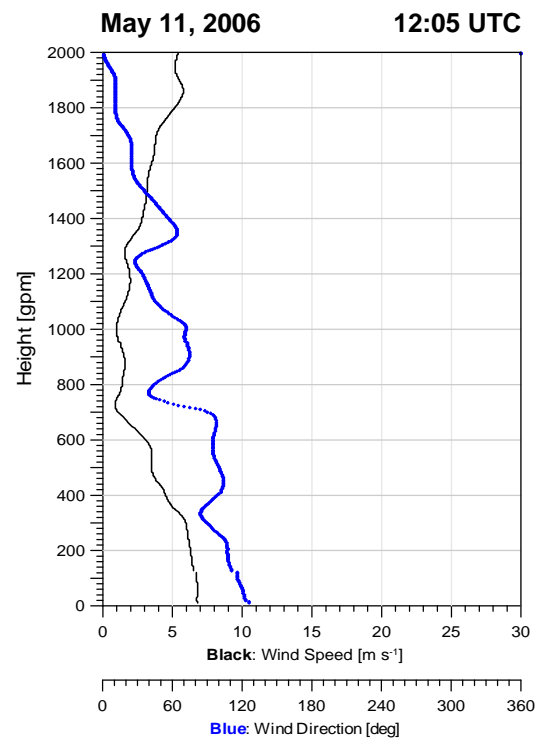
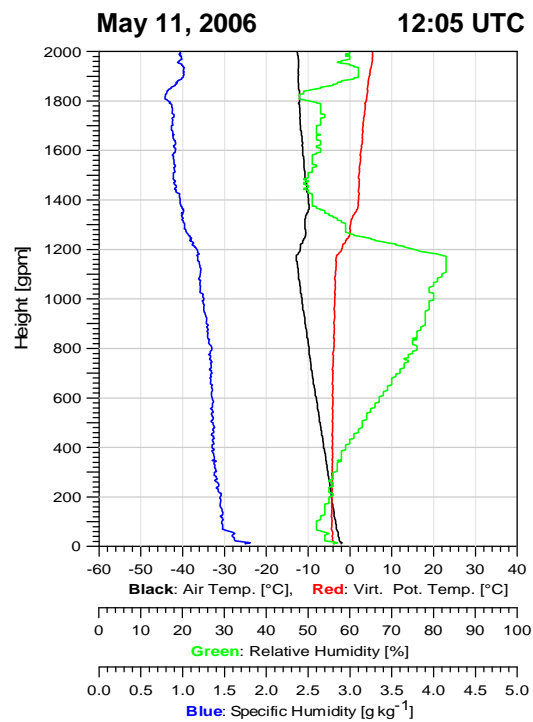
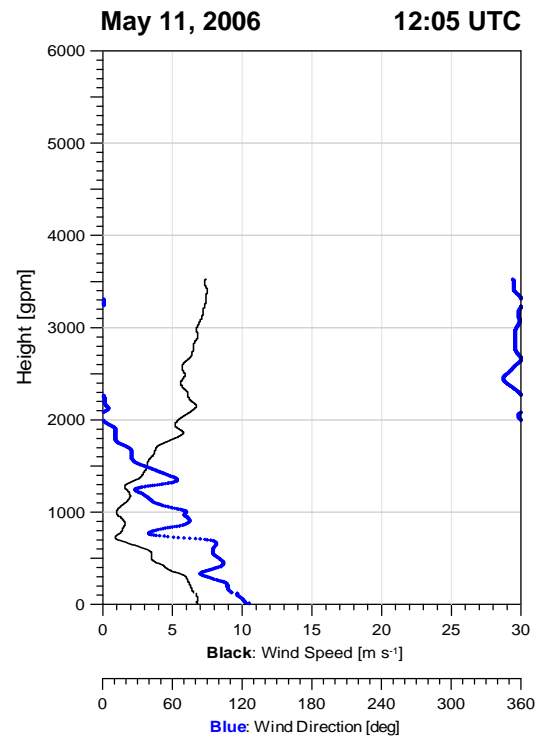
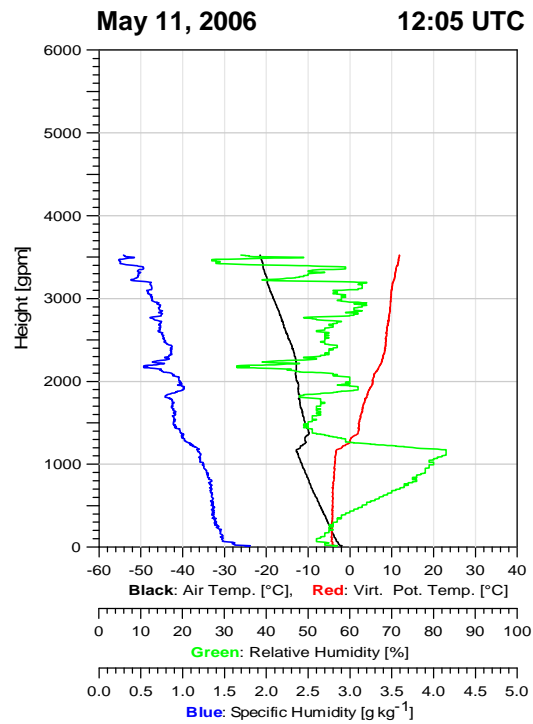


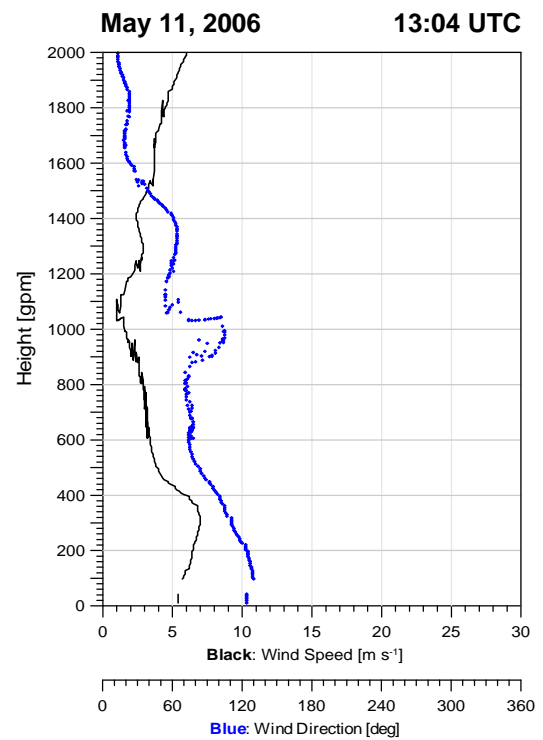
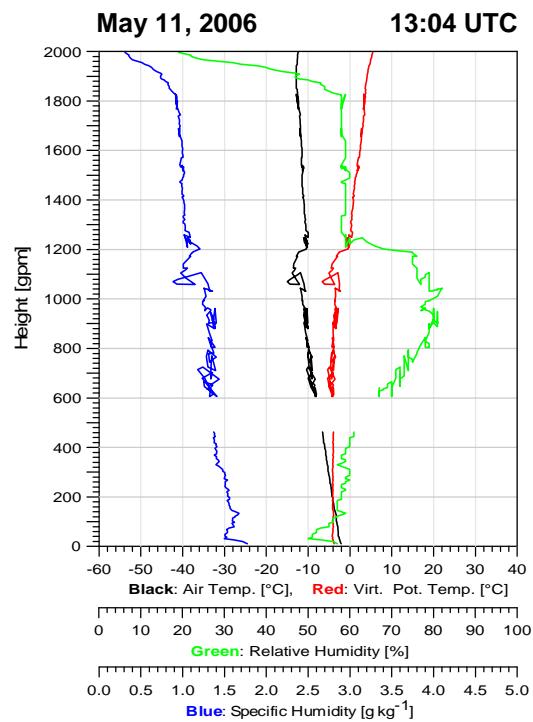
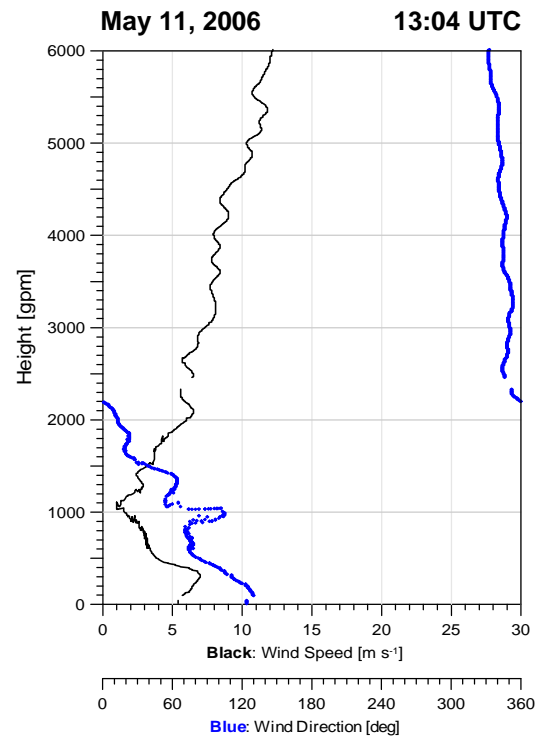
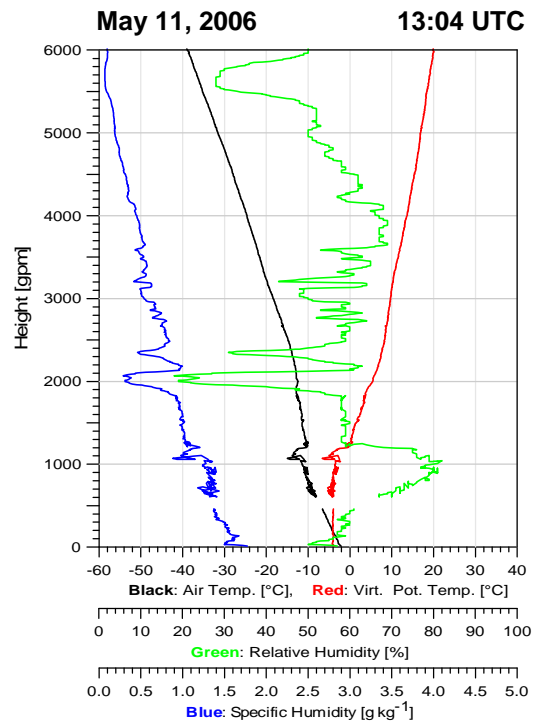


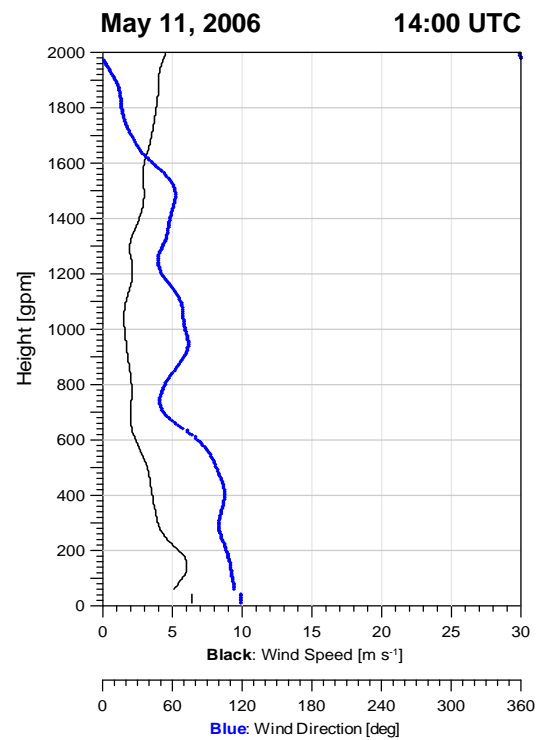
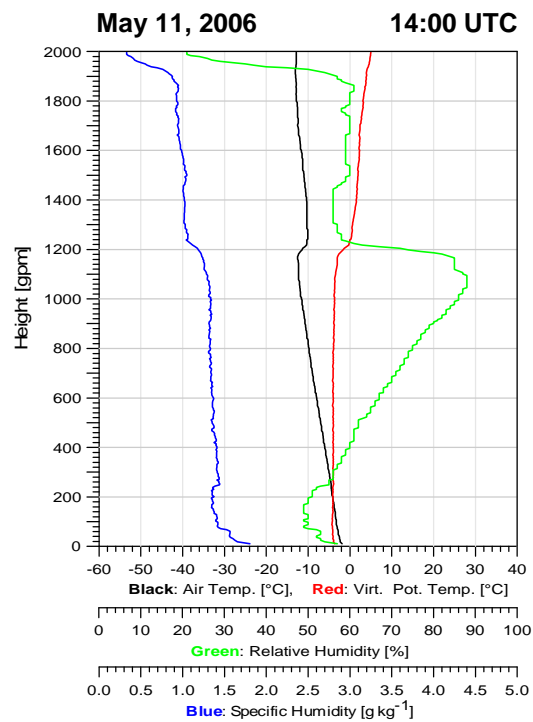
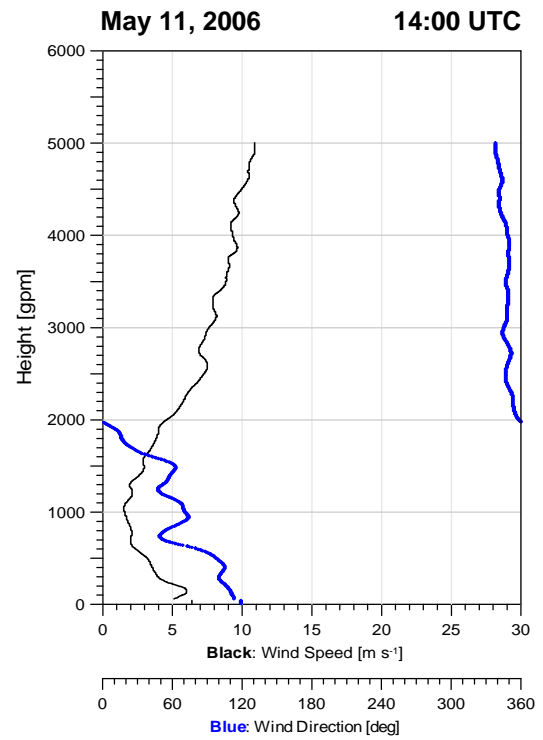
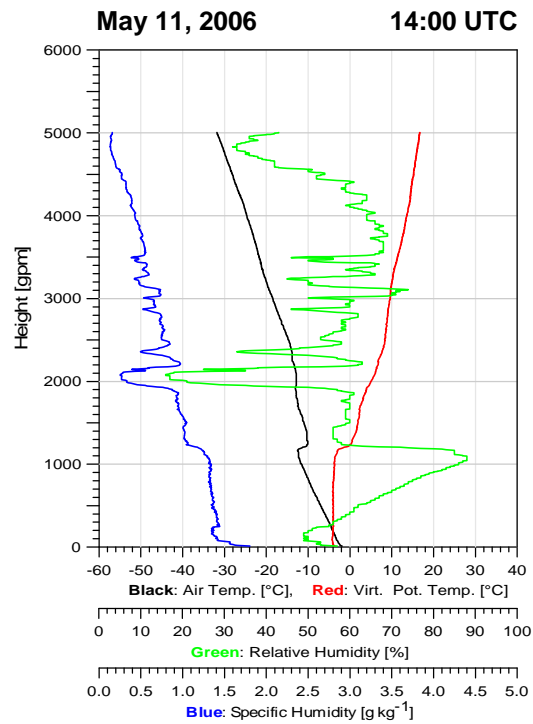


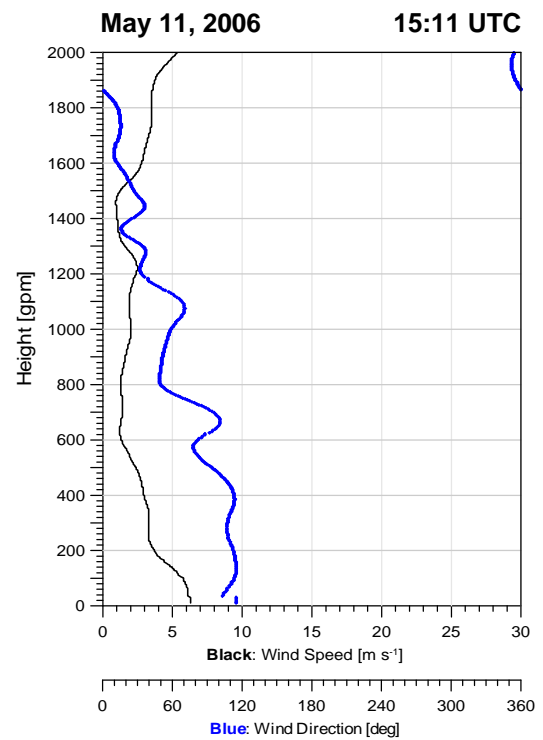
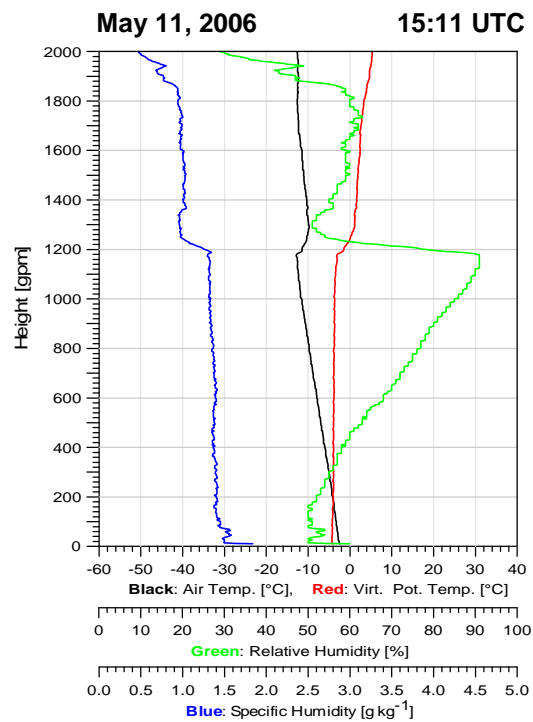
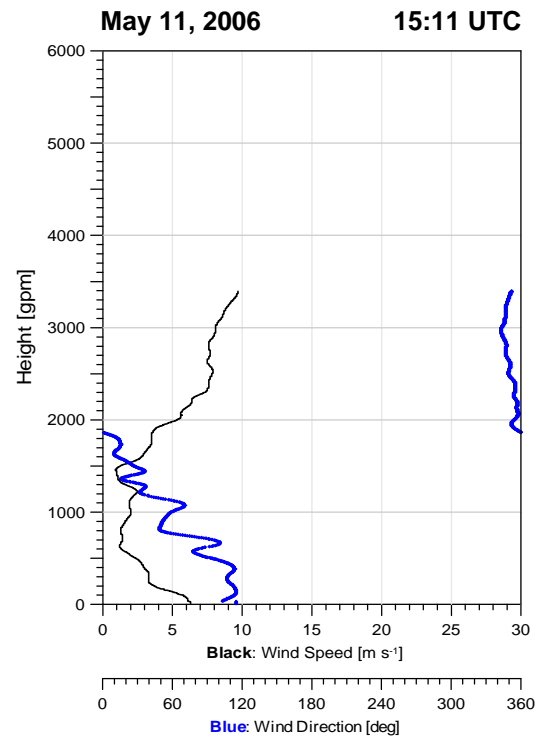
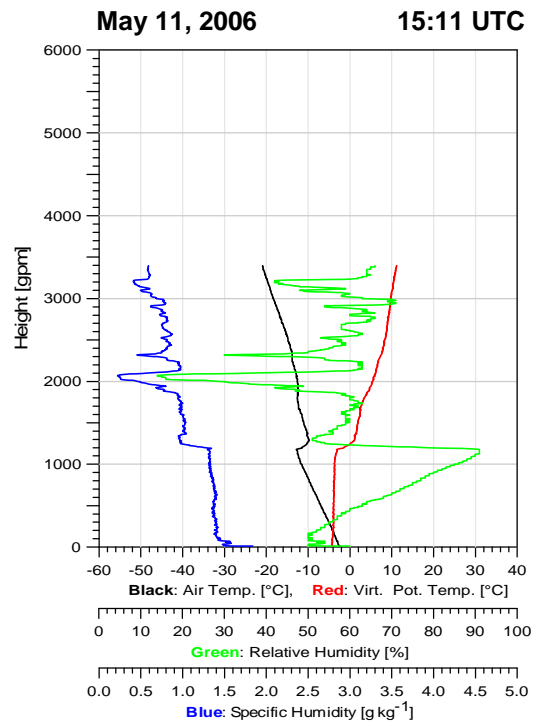


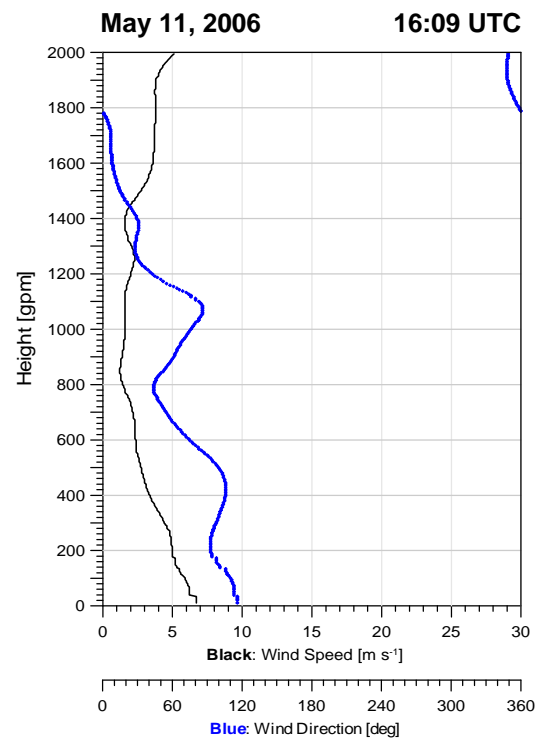
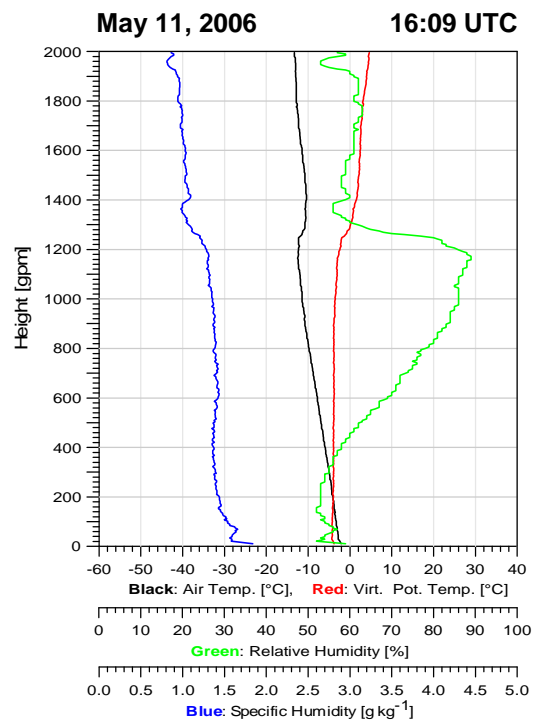
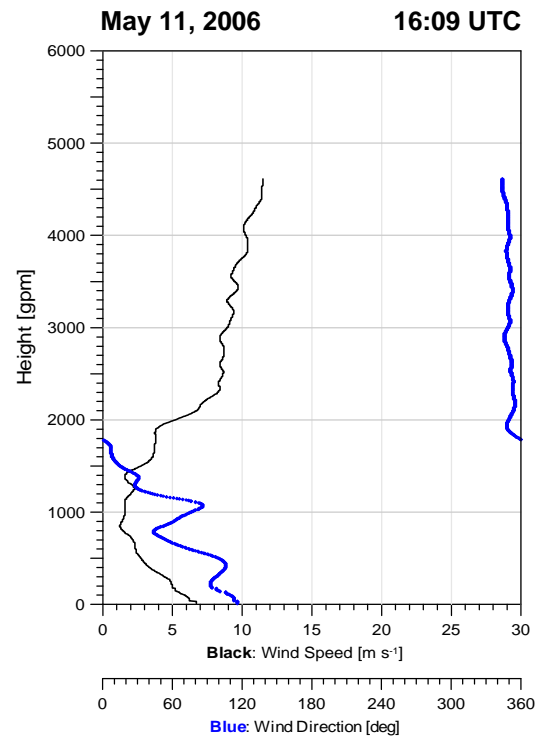
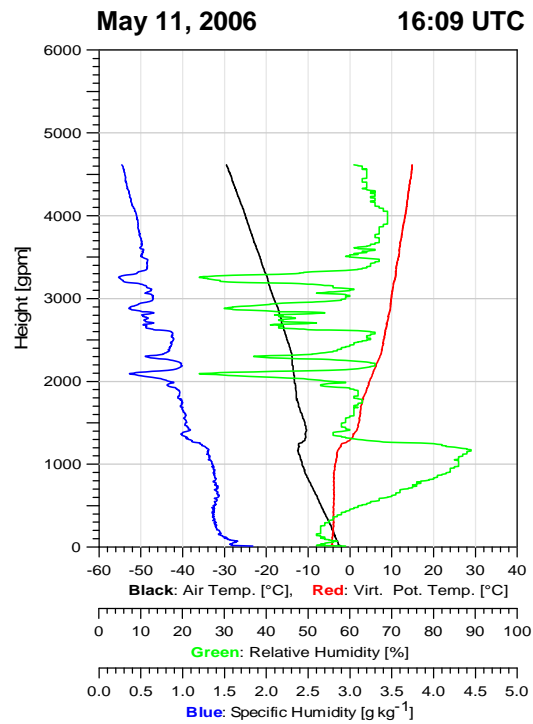


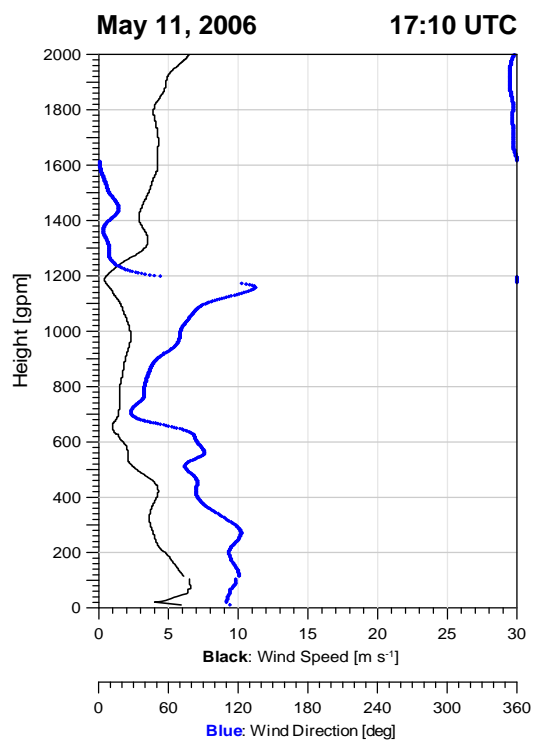
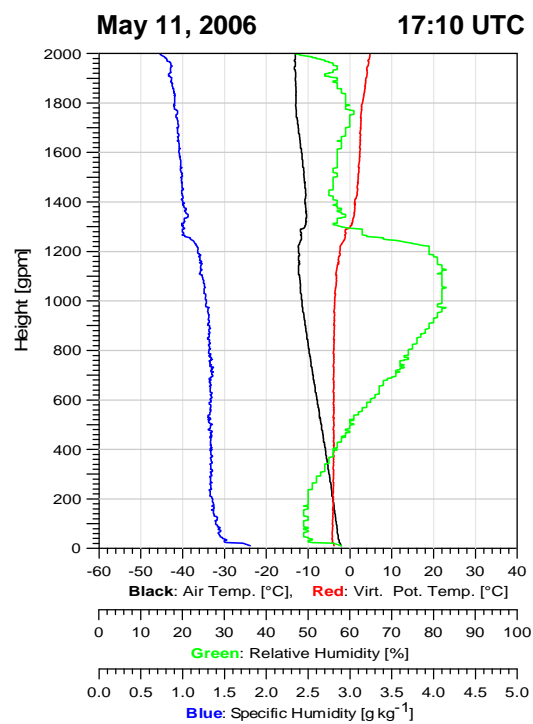
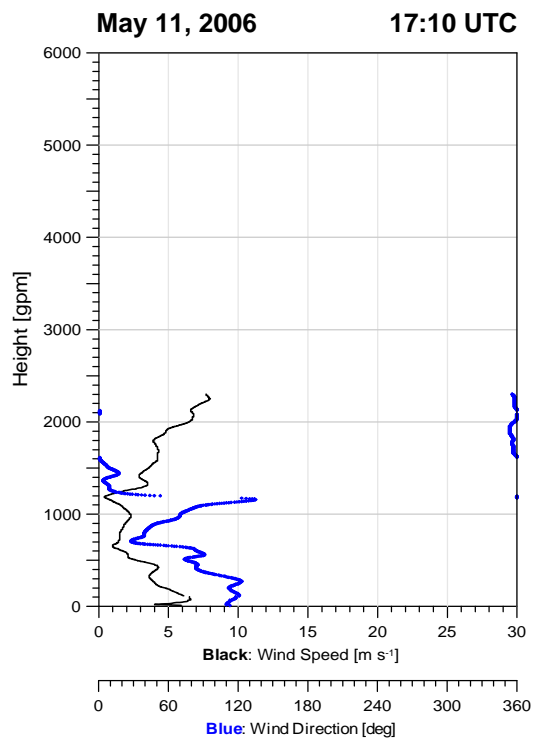
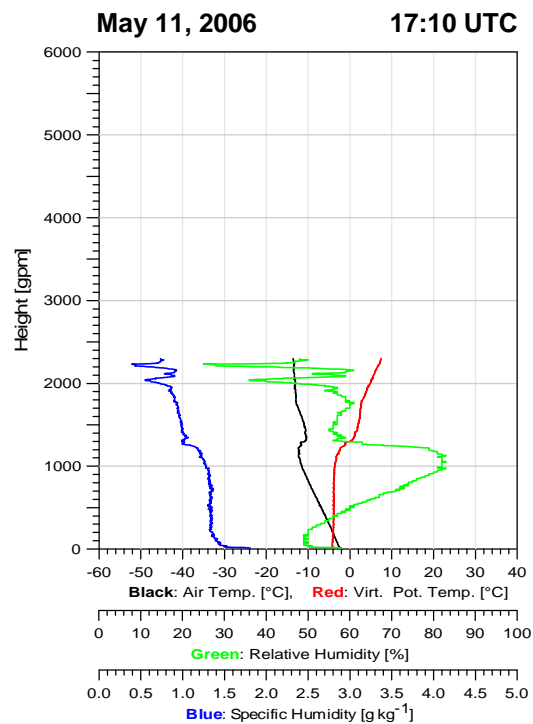


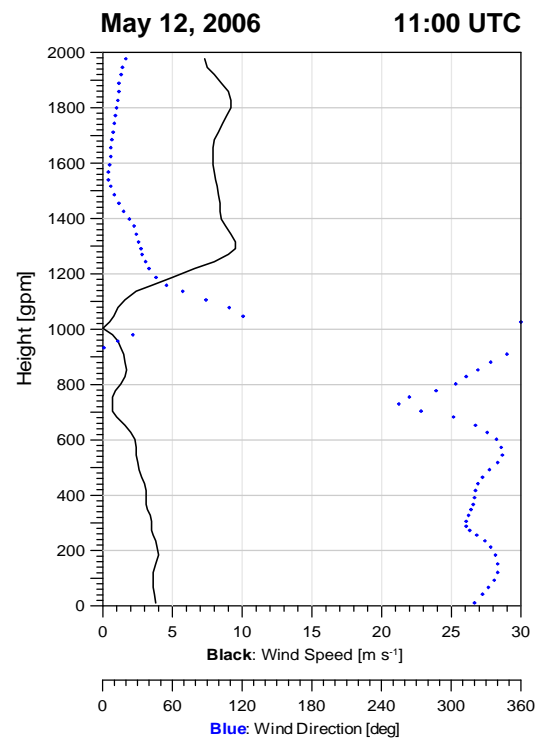
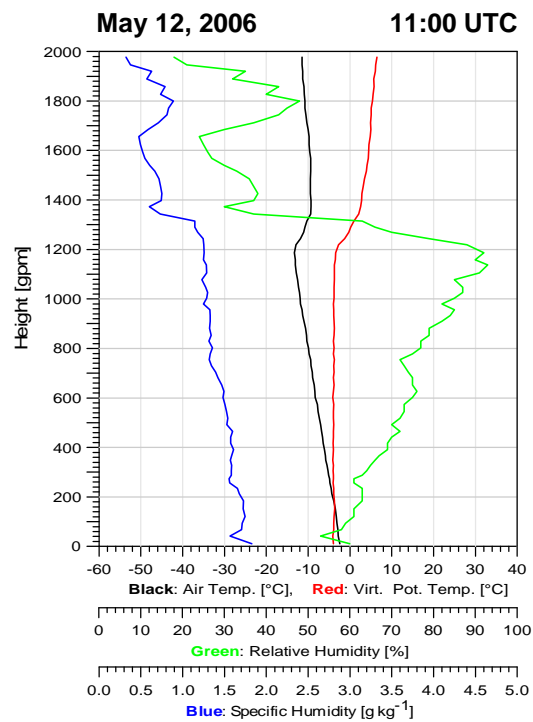
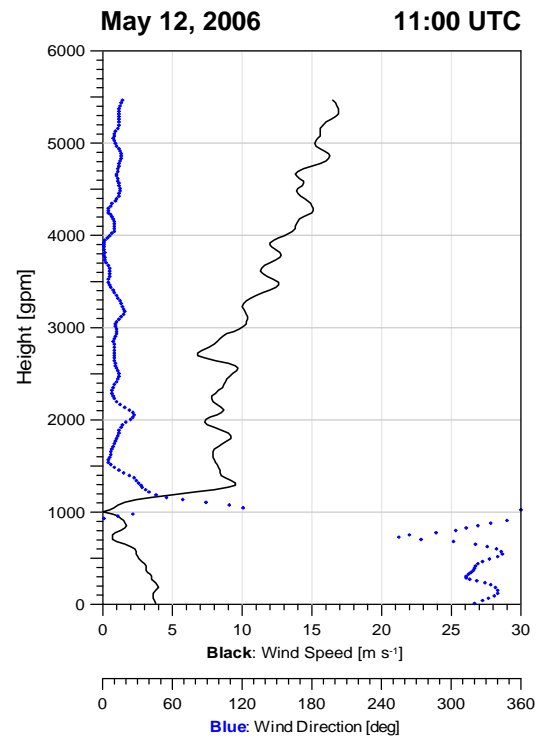
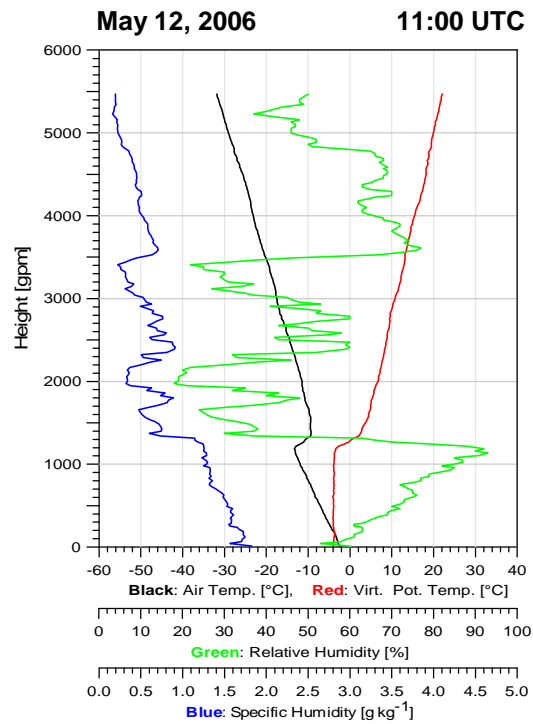


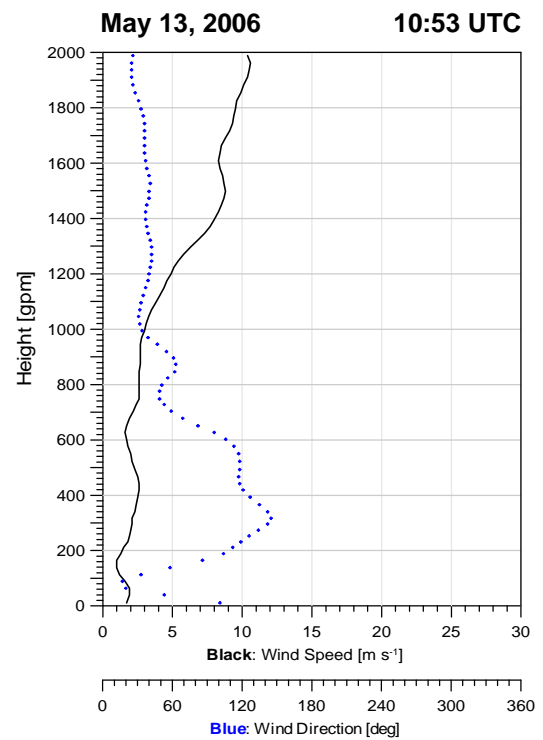
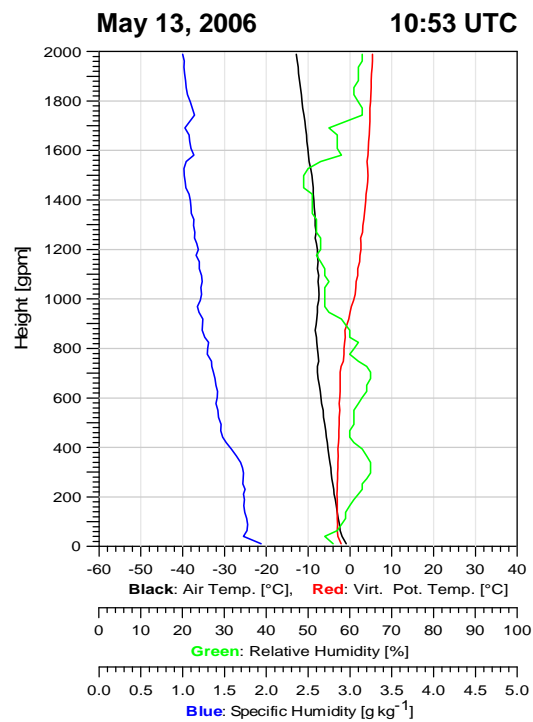
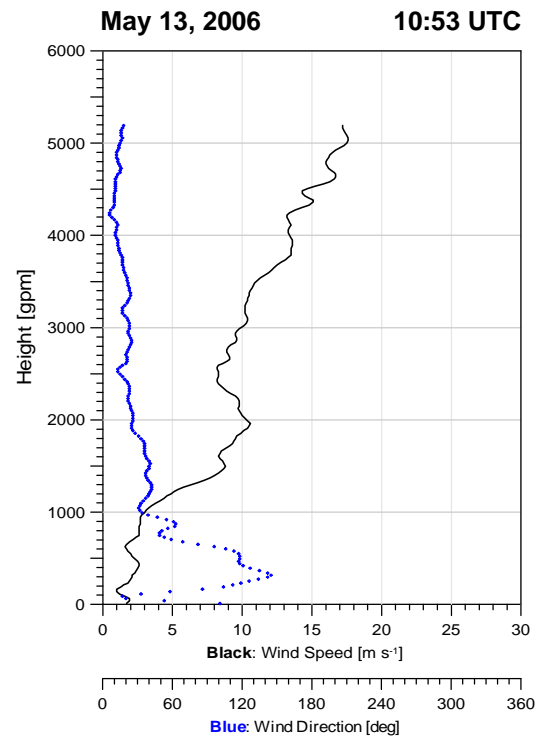
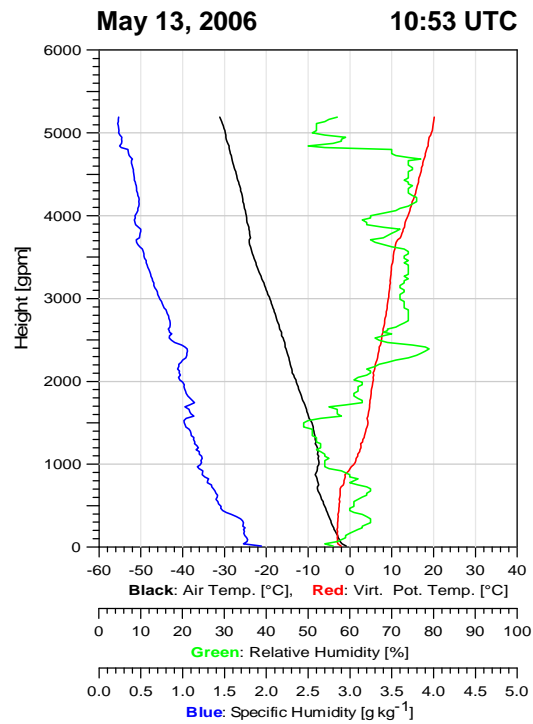


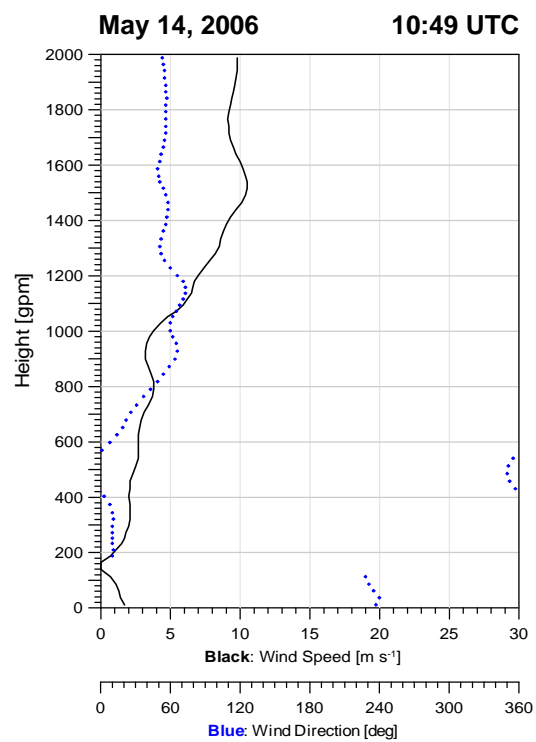
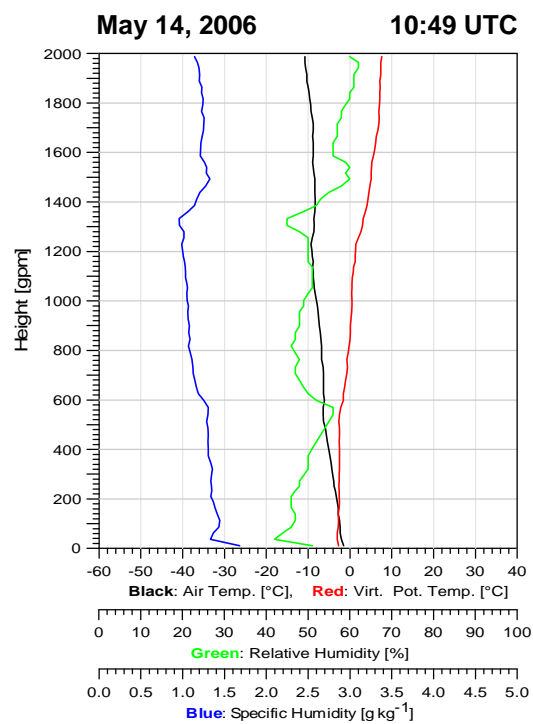
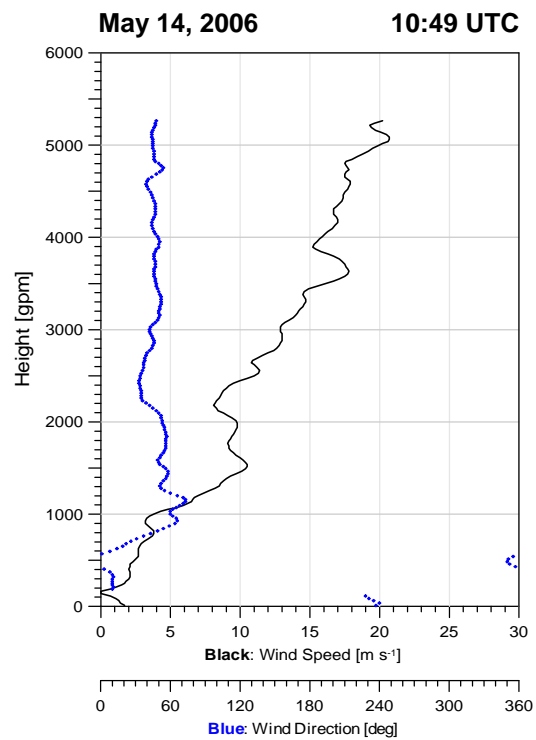
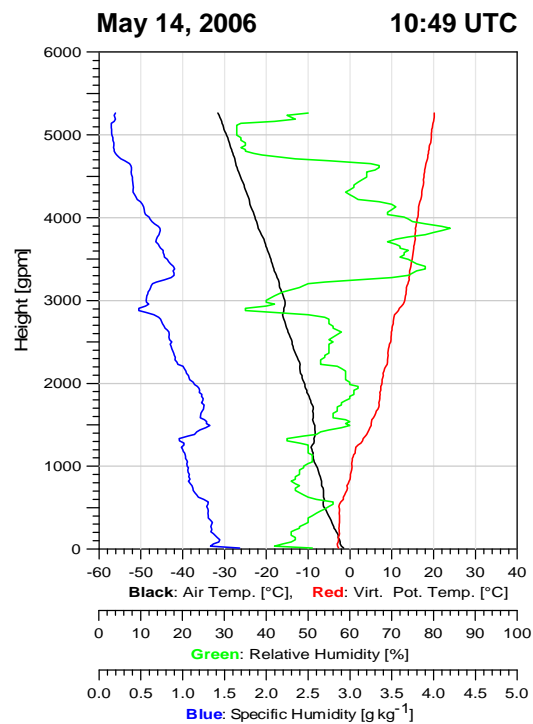


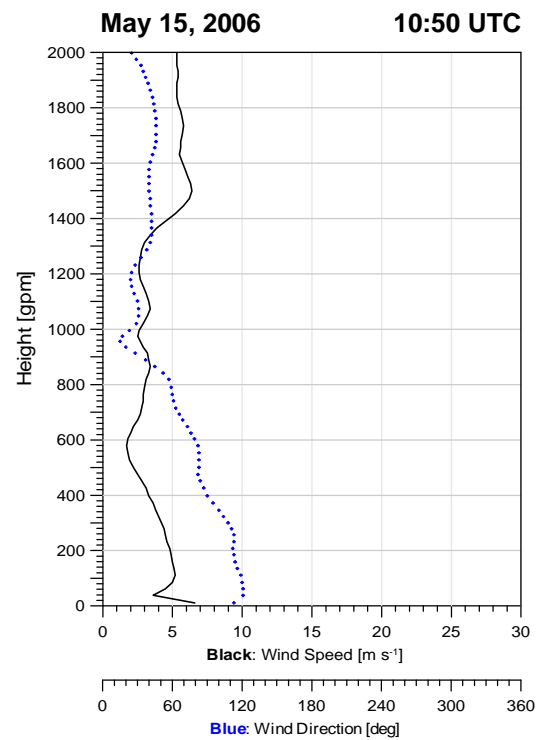
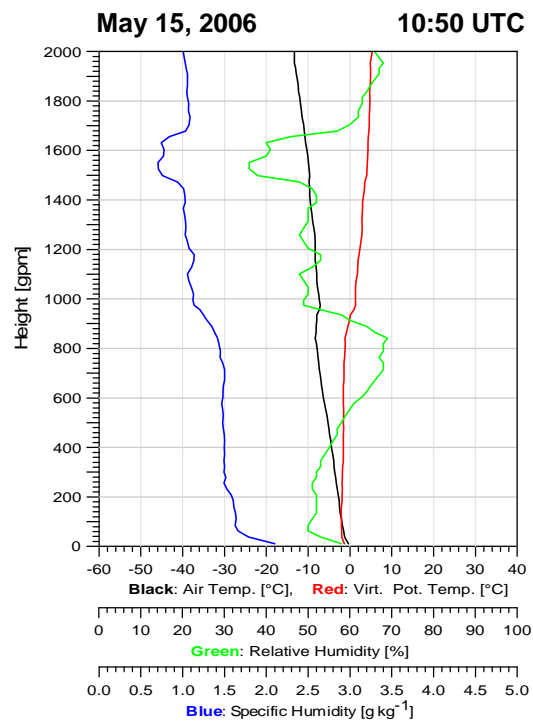
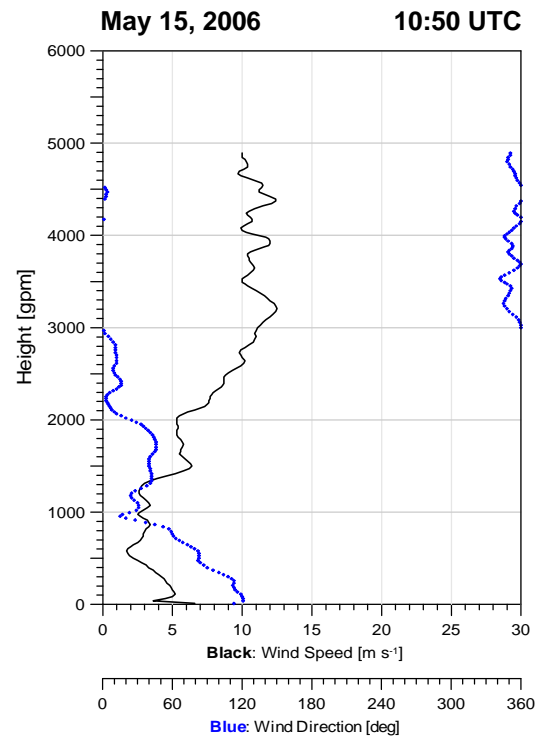
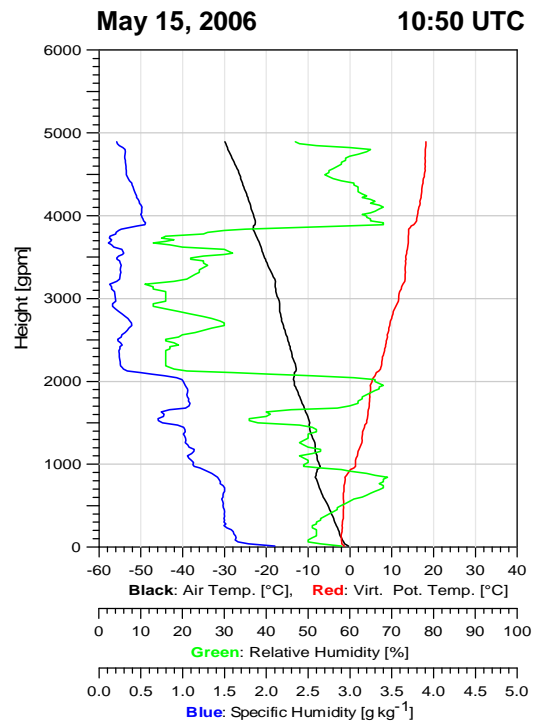


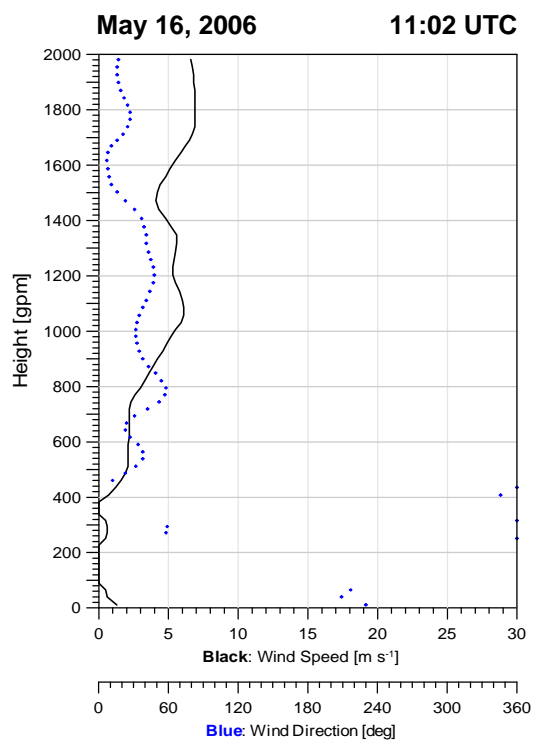
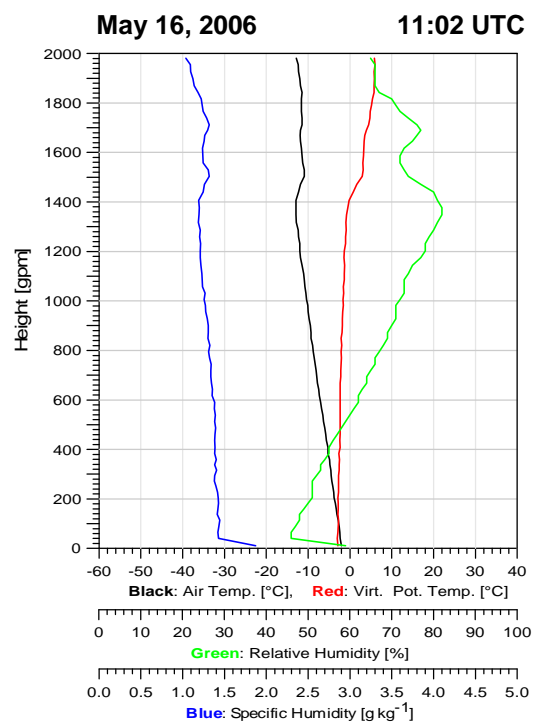
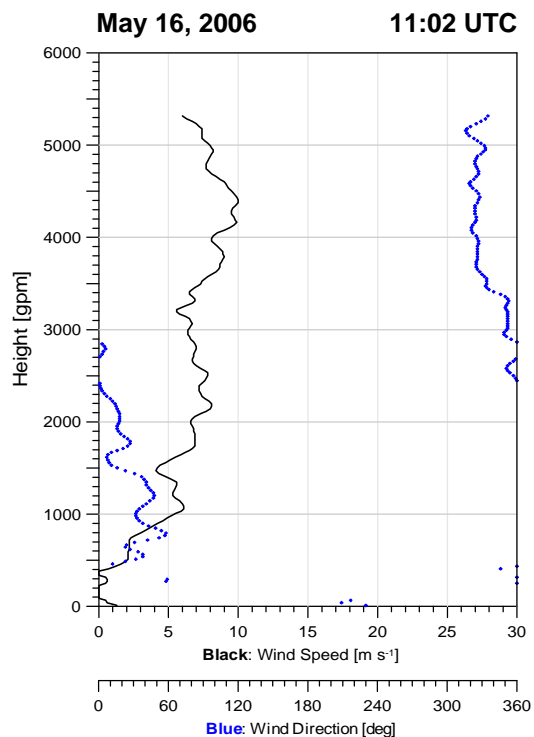
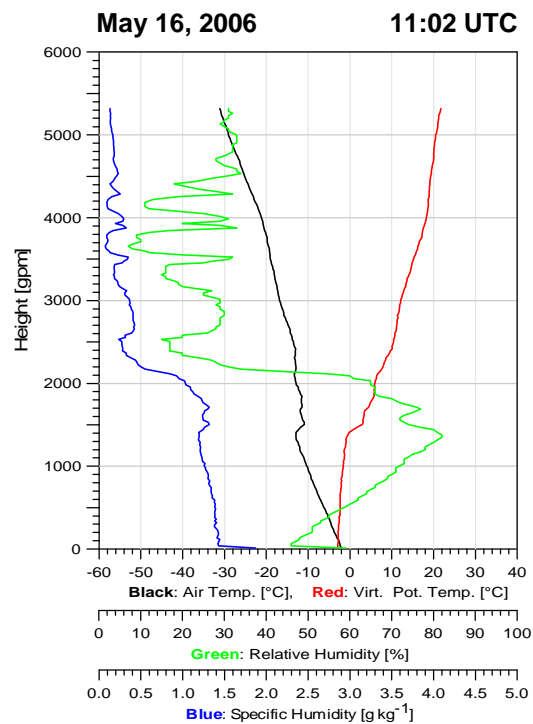


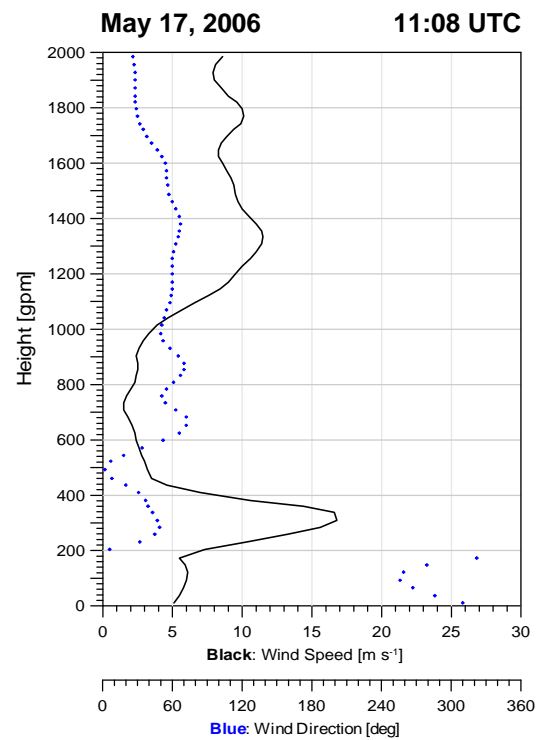
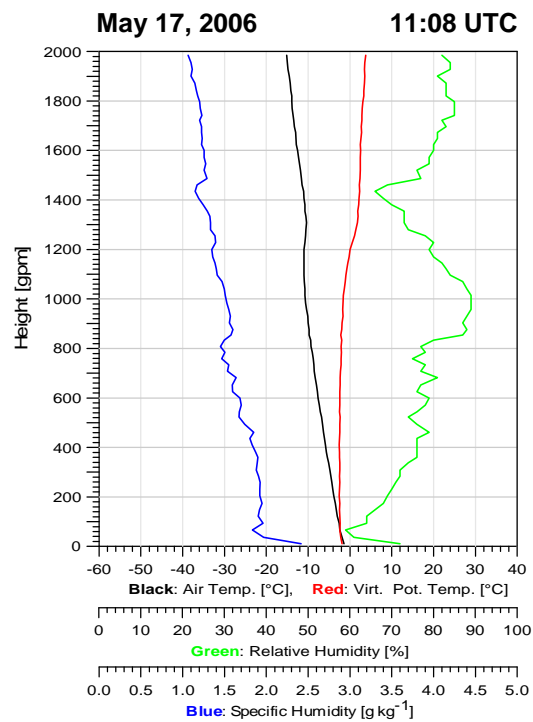
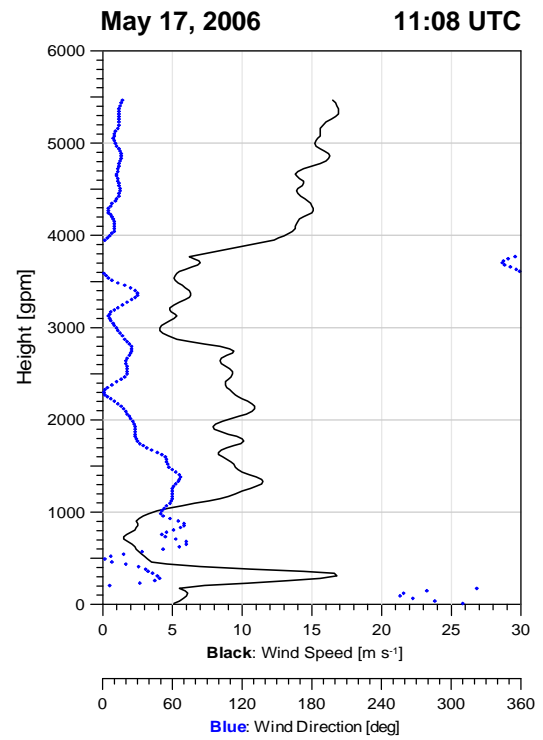
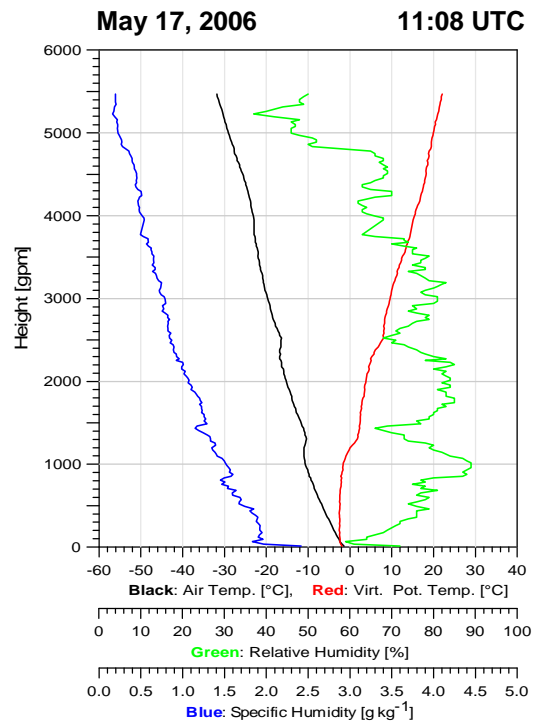


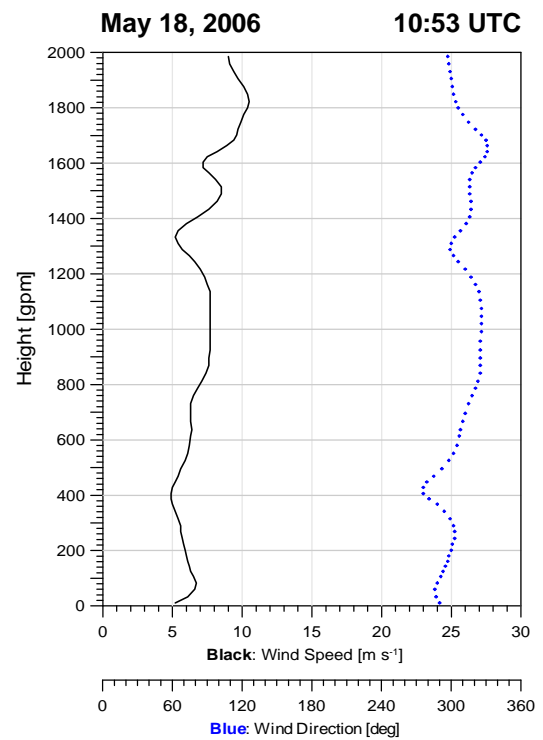
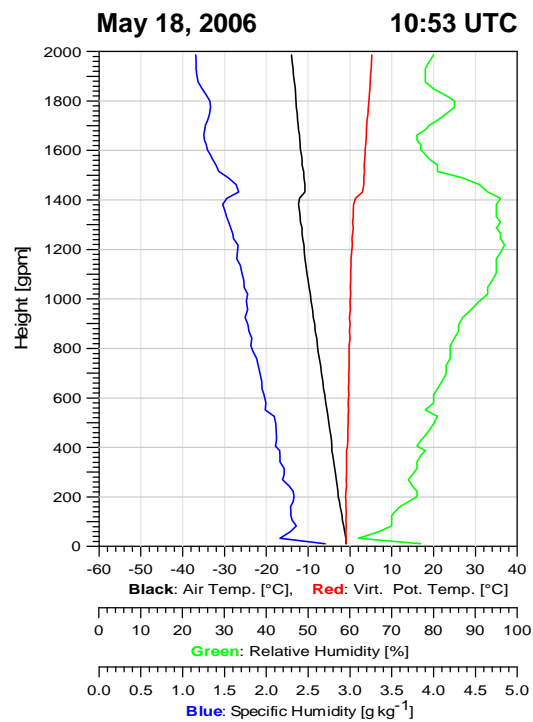
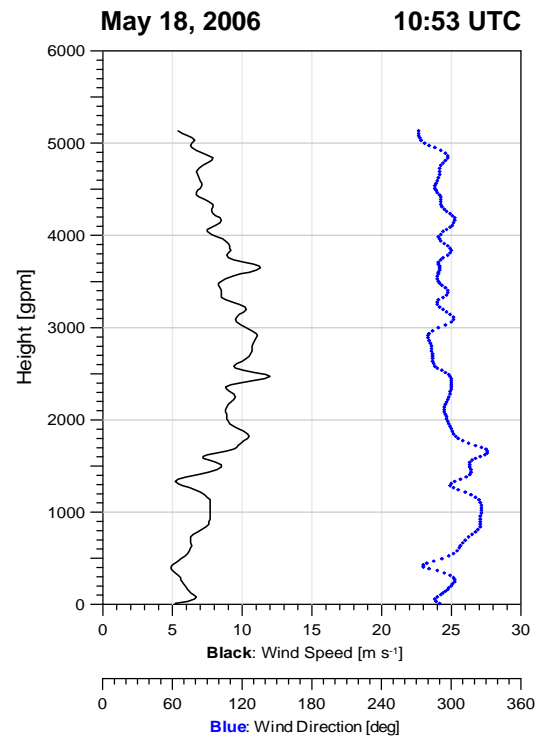
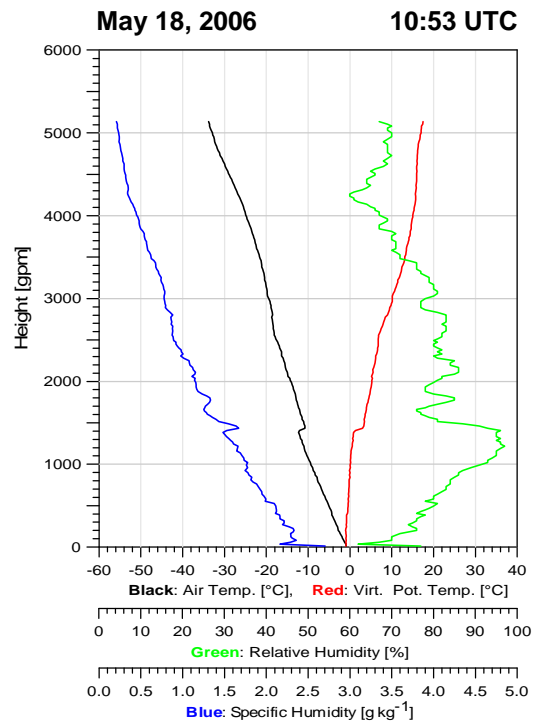


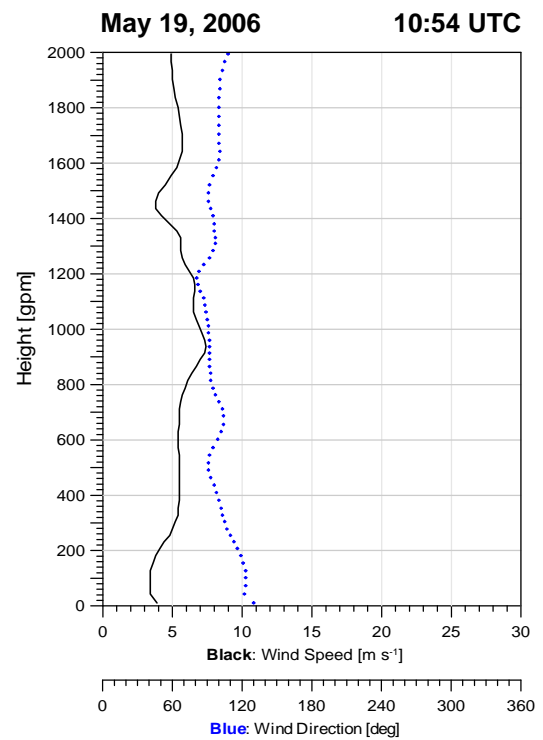
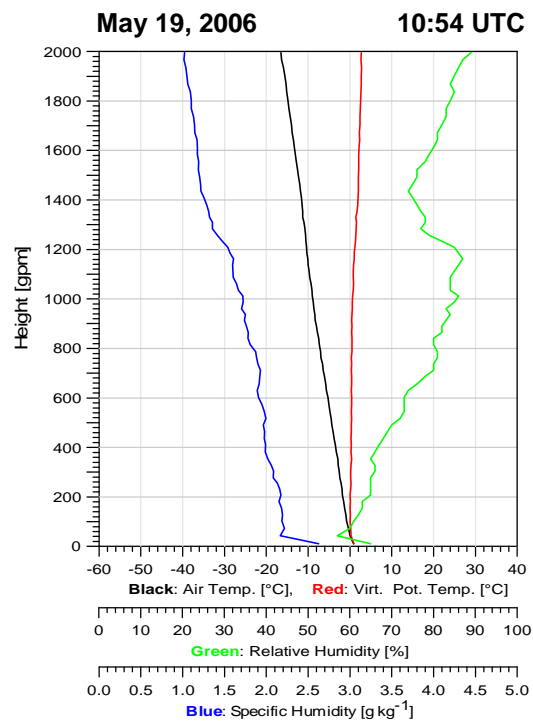
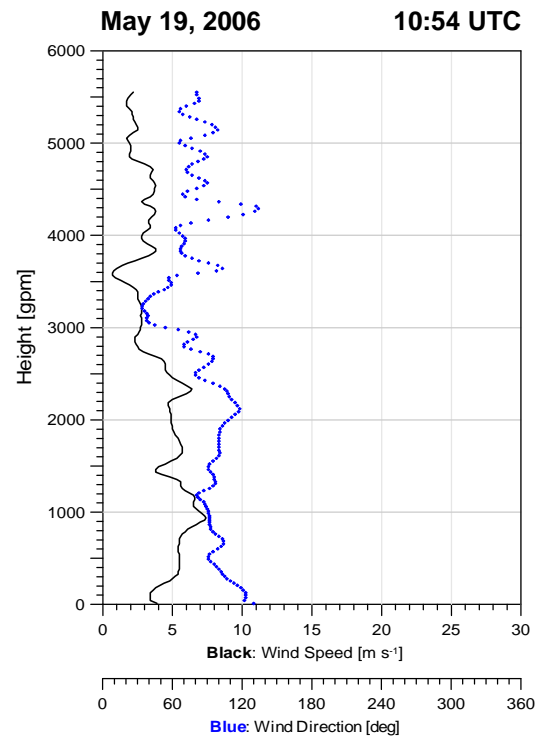
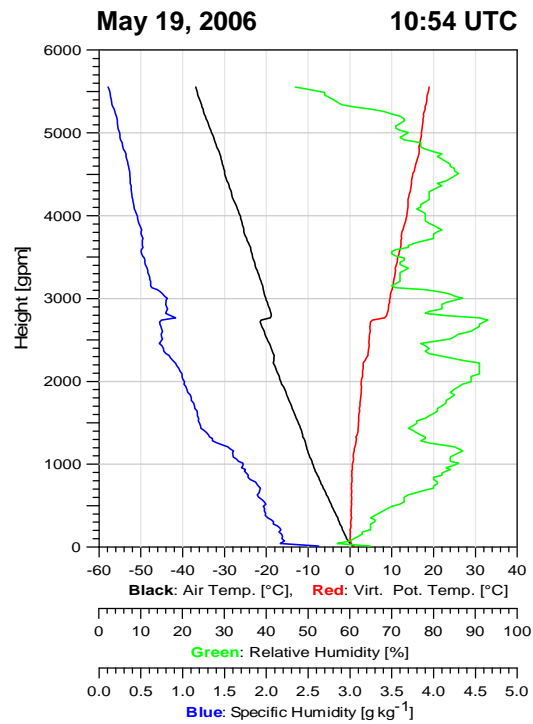


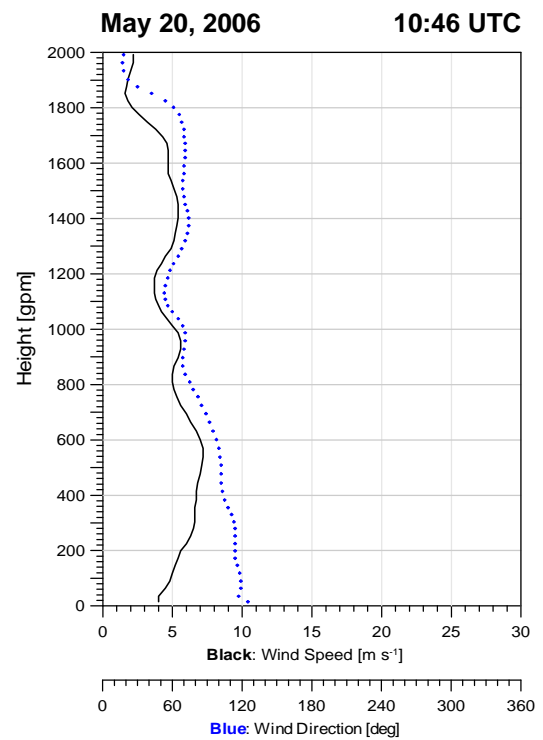
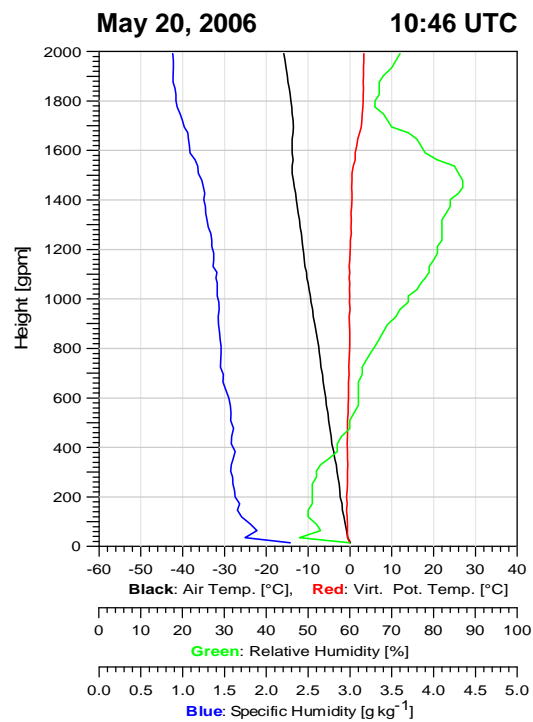
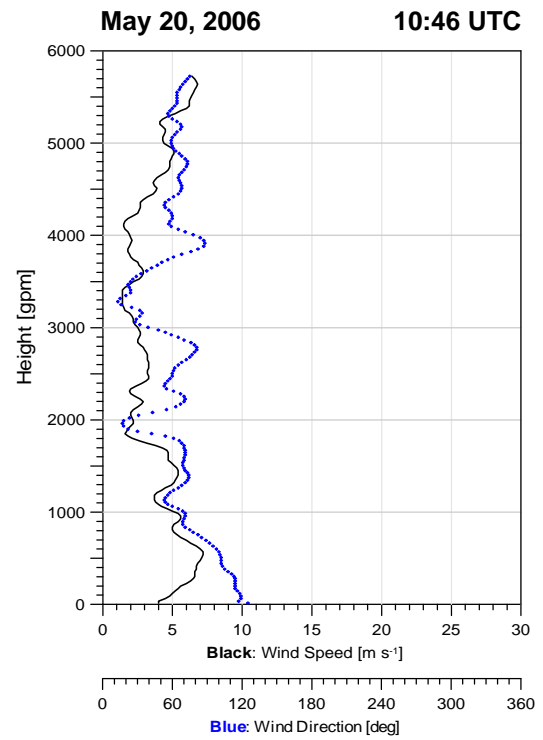
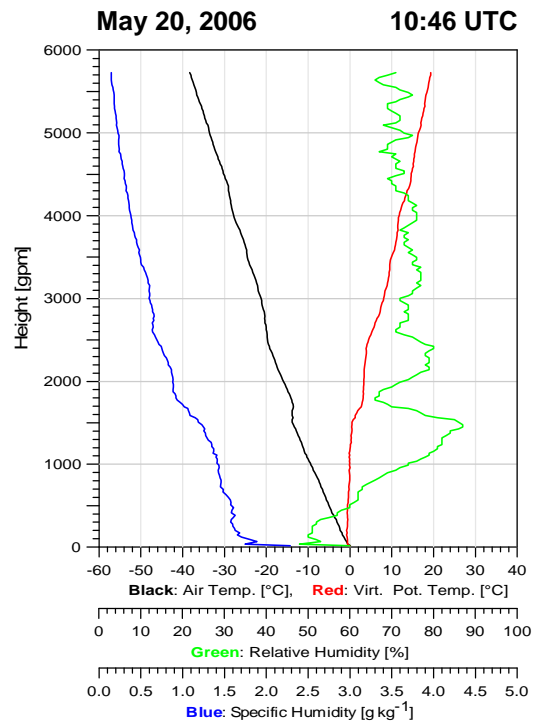










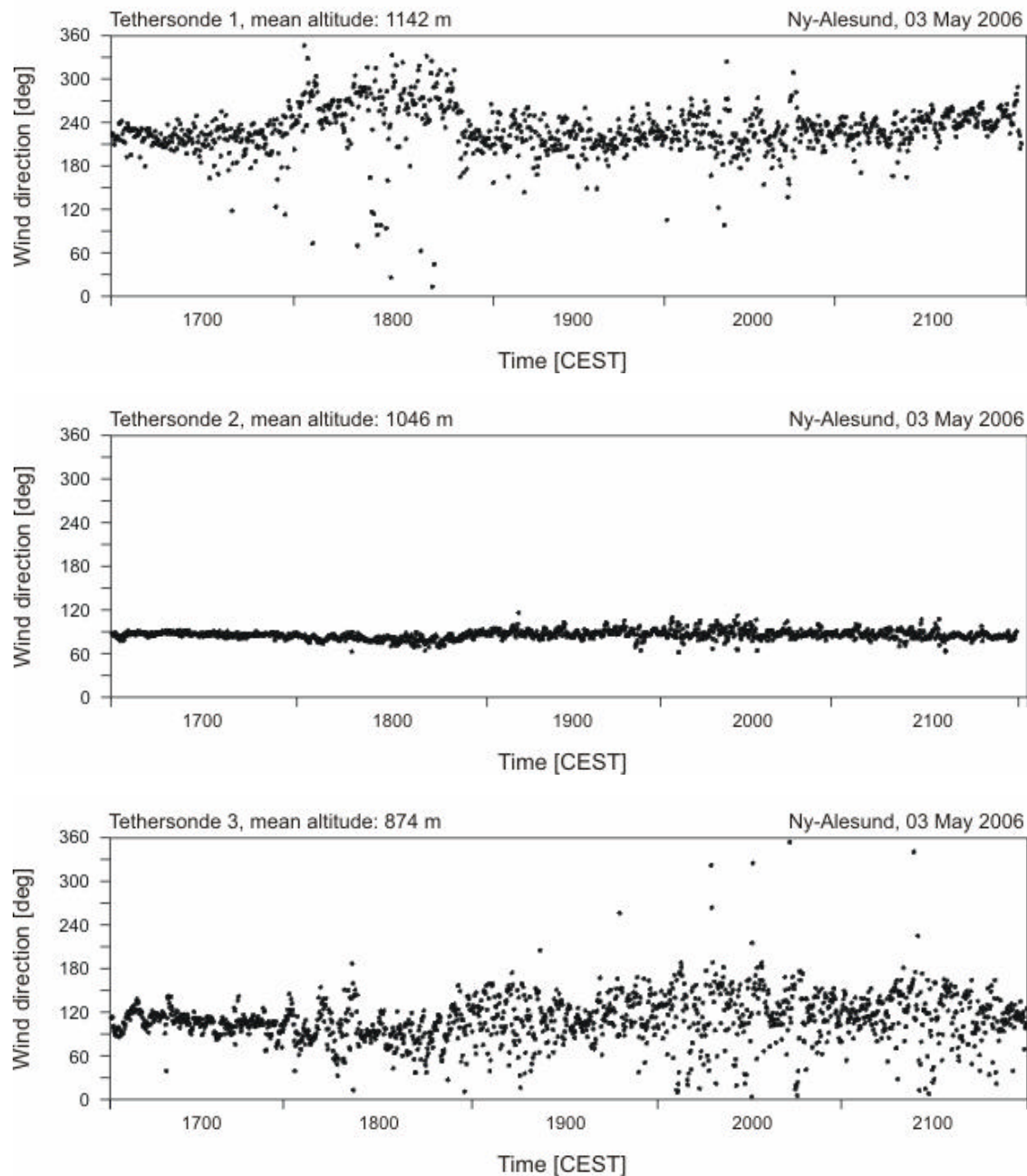


5.2 Tethersonde observations

Data transmission from sondes was variable, up to six times a minute. Time series of wind direction and wind roses contain non-averaged raw data as transmitted by the sensors. The scales of the wind roses are variable.

5.2.1 Vertical sounding on 3 May 2006

Time series of wind direction (1700 to 2200 CEST)



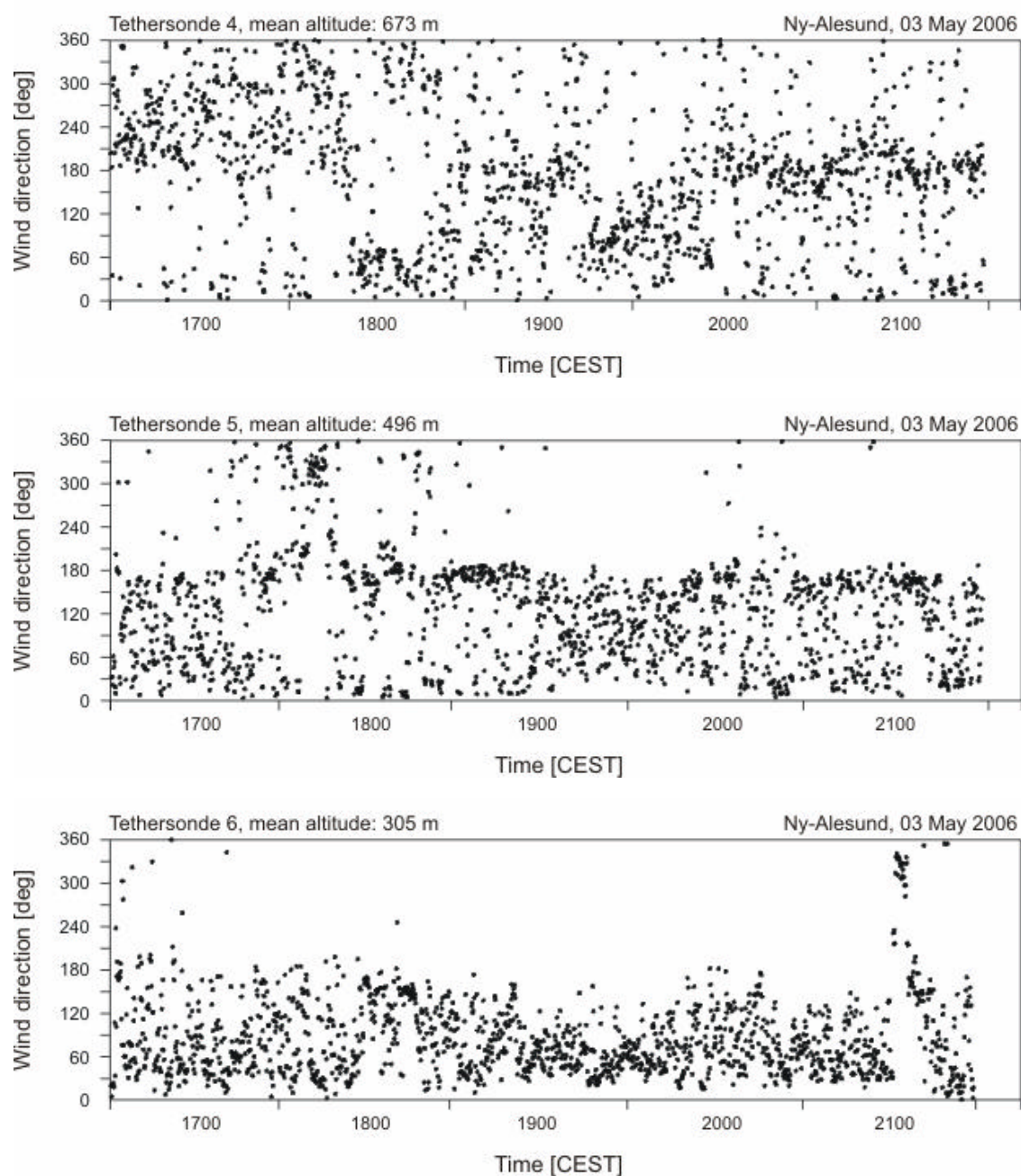


Figure 5.1: Time series of wind direction derived from tethersonde soundings at six different levels over Ny-Ålesund (Svalbard), 3 May 2006, 1700 to 2200 CEST.

Frequency distribution of wind direction (1700 to 2159 CEST)

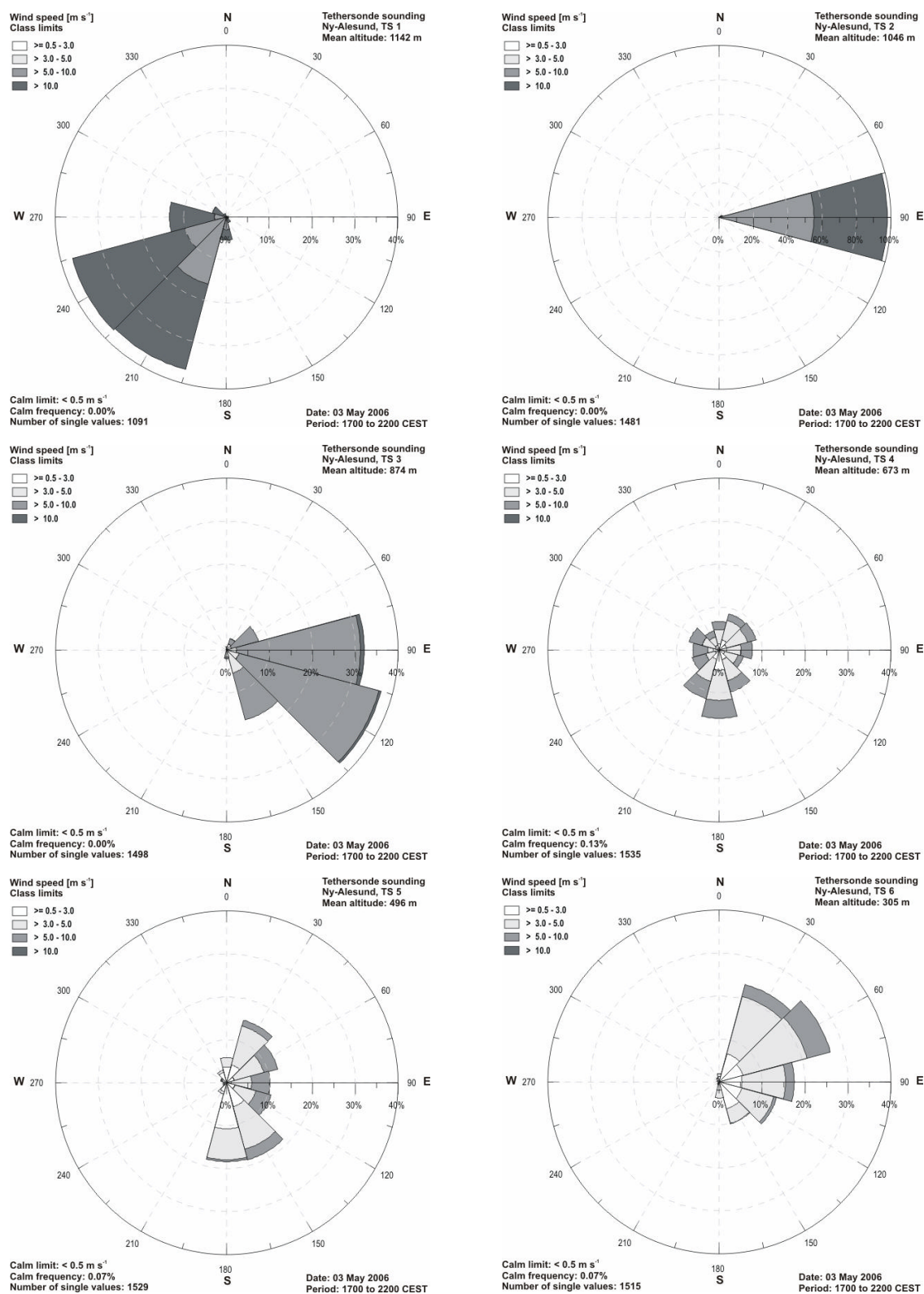
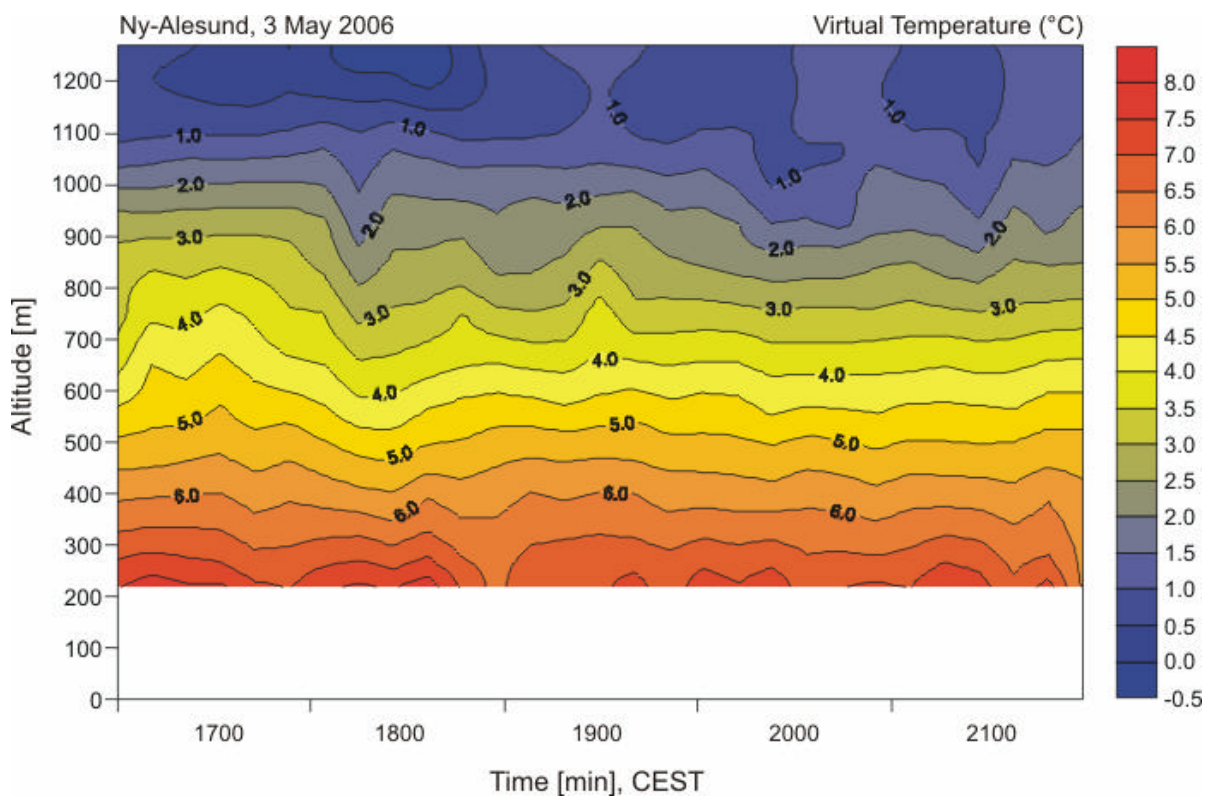
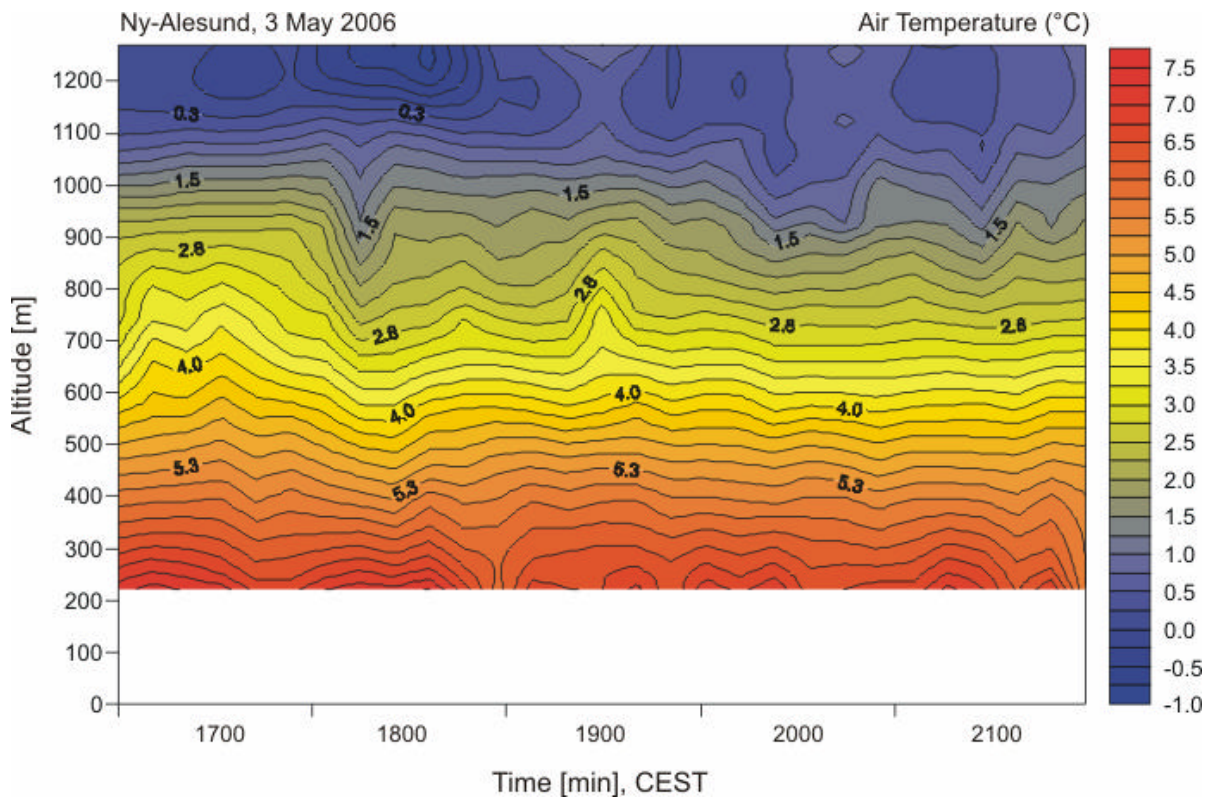
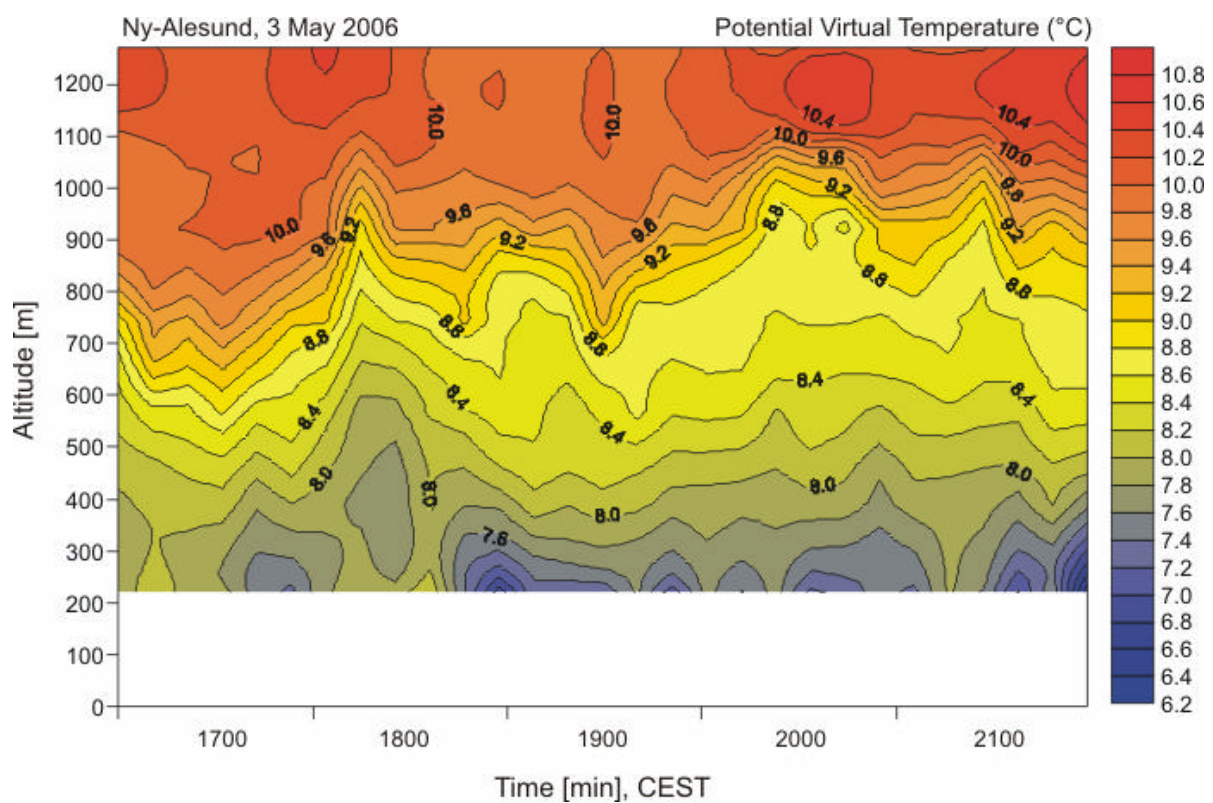
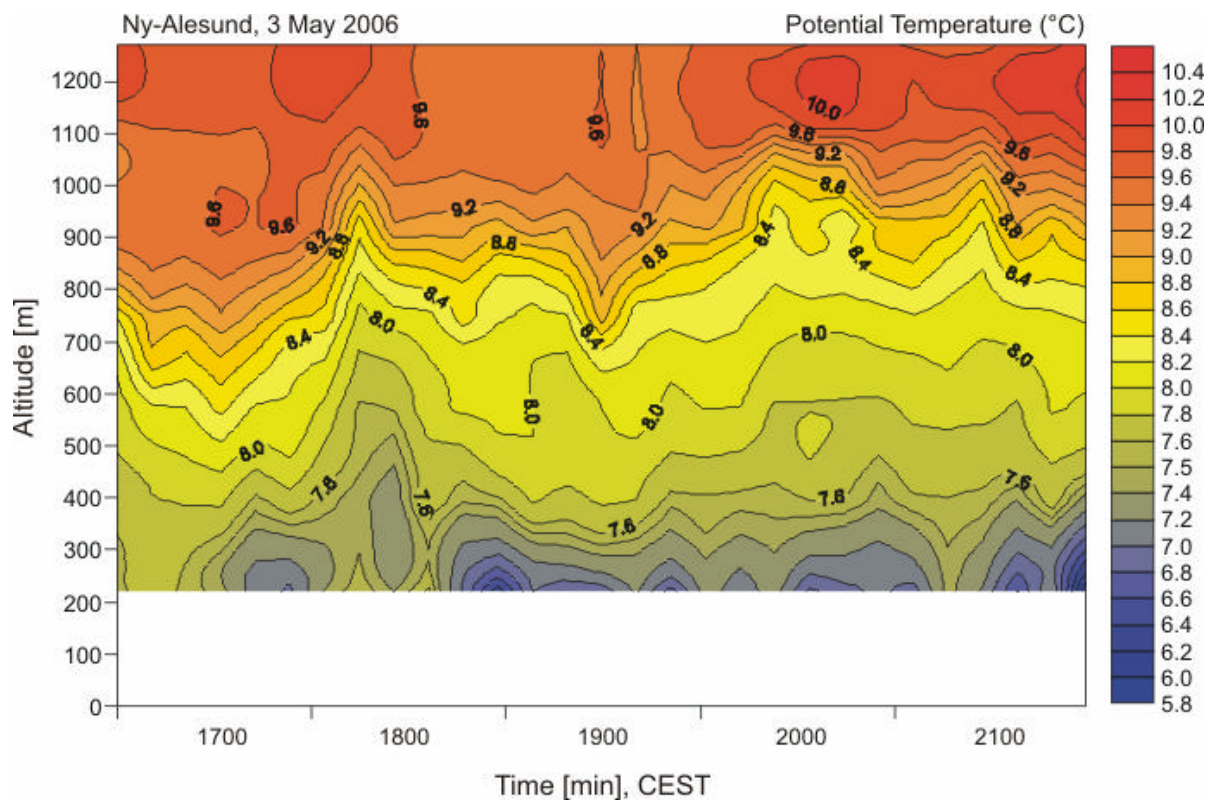
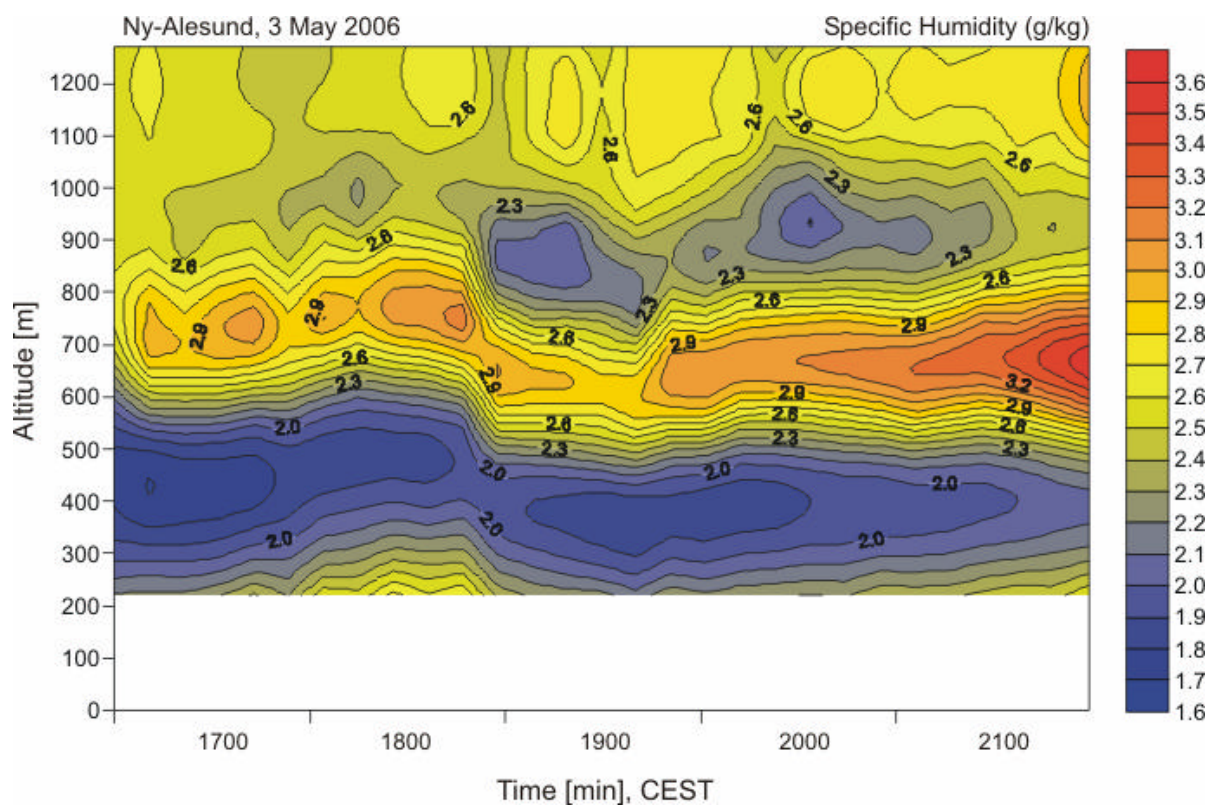
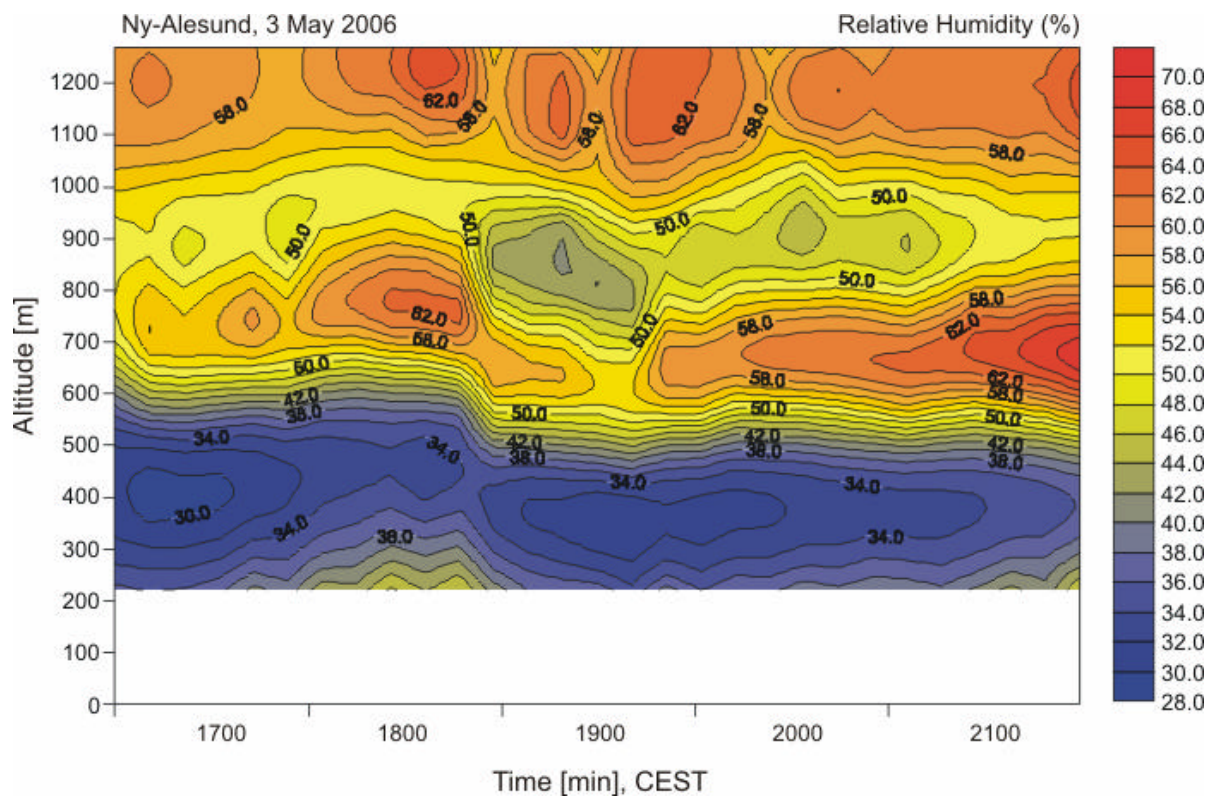


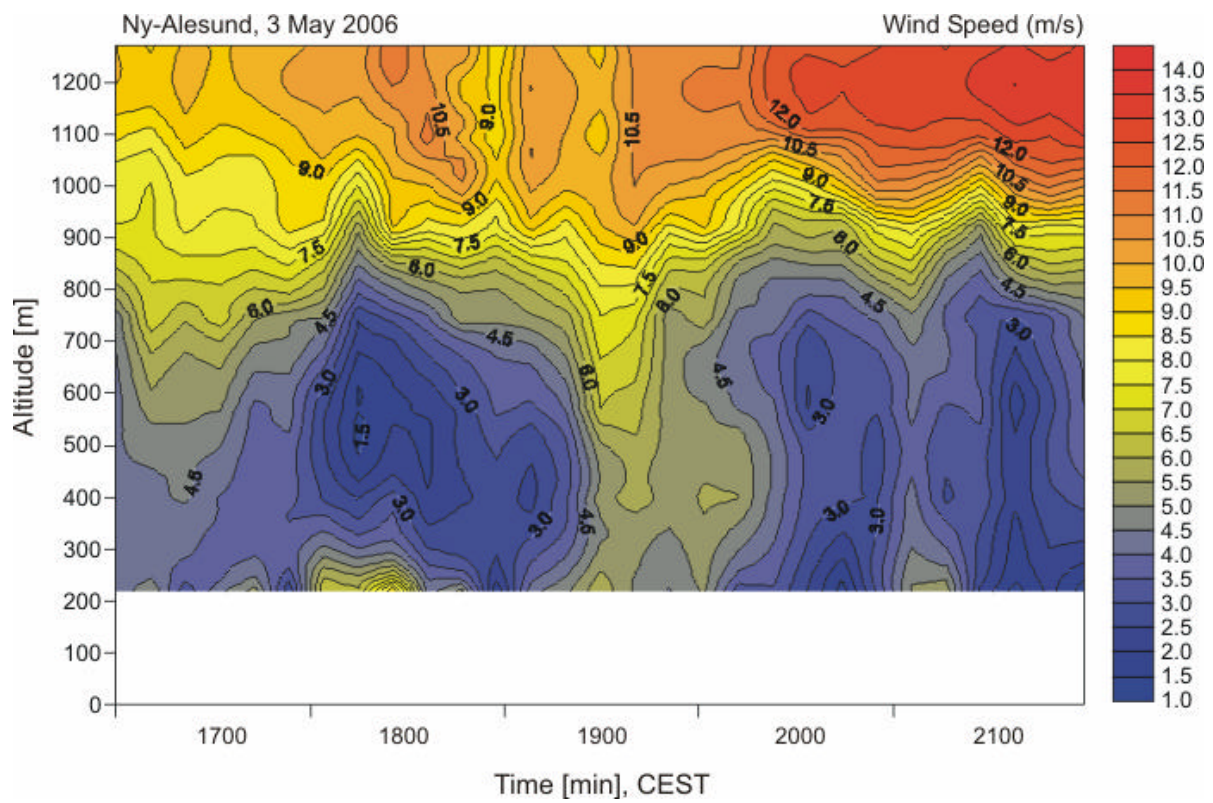
Figure 5.2: Frequency distribution of wind direction with polar coordinates derived from tethered soundings at six different levels over Ny-Ålesund (Svalbard), 3 May 2006, 1700 to 2200 CEST.

Hovmoeller plots (time/height) of meteorological elements (1700 to 2159 CEST)



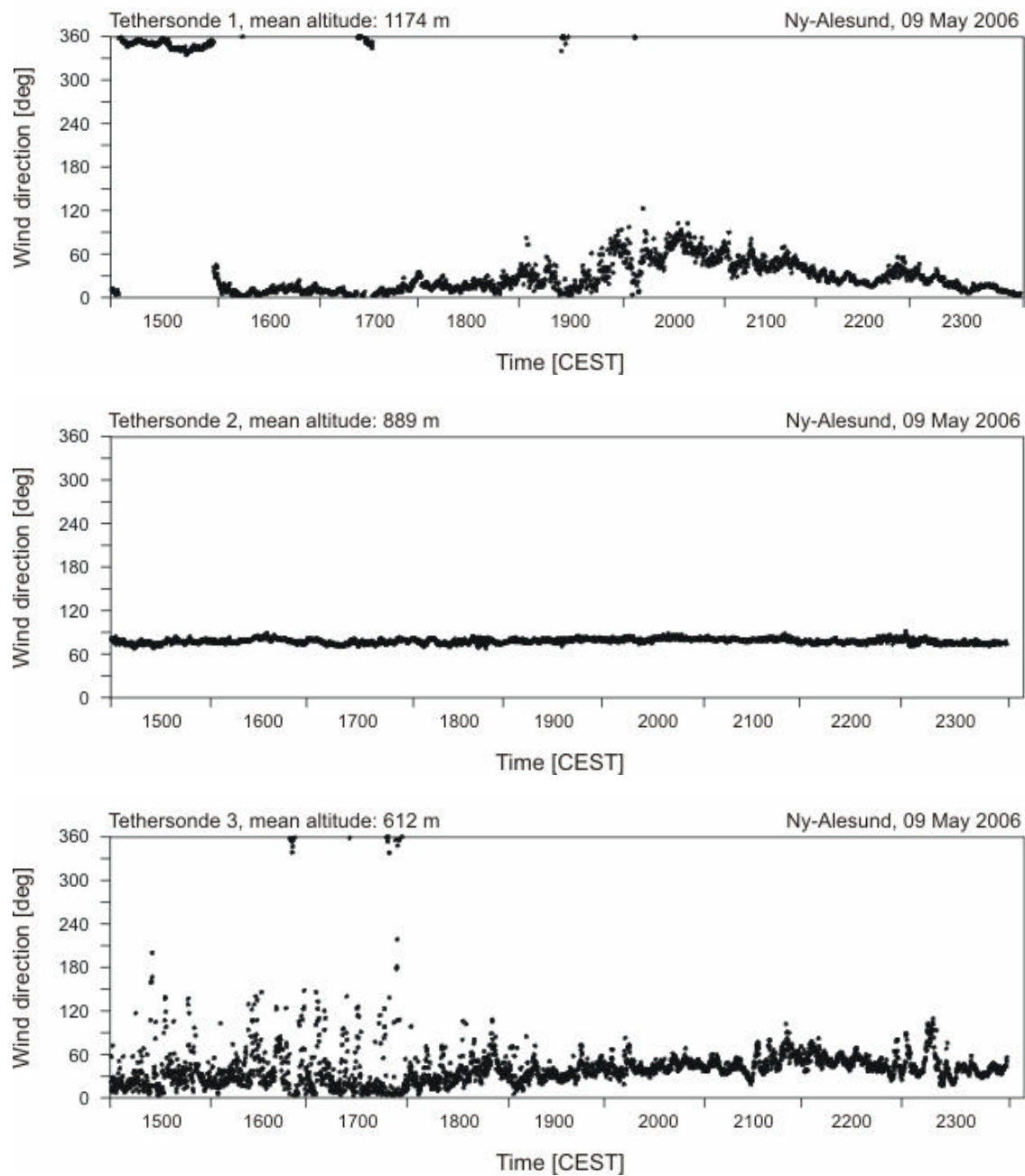






5.2.2 Vertical sounding on 9 May 2006

Time series of wind direction (1500 to 2359 CEST)



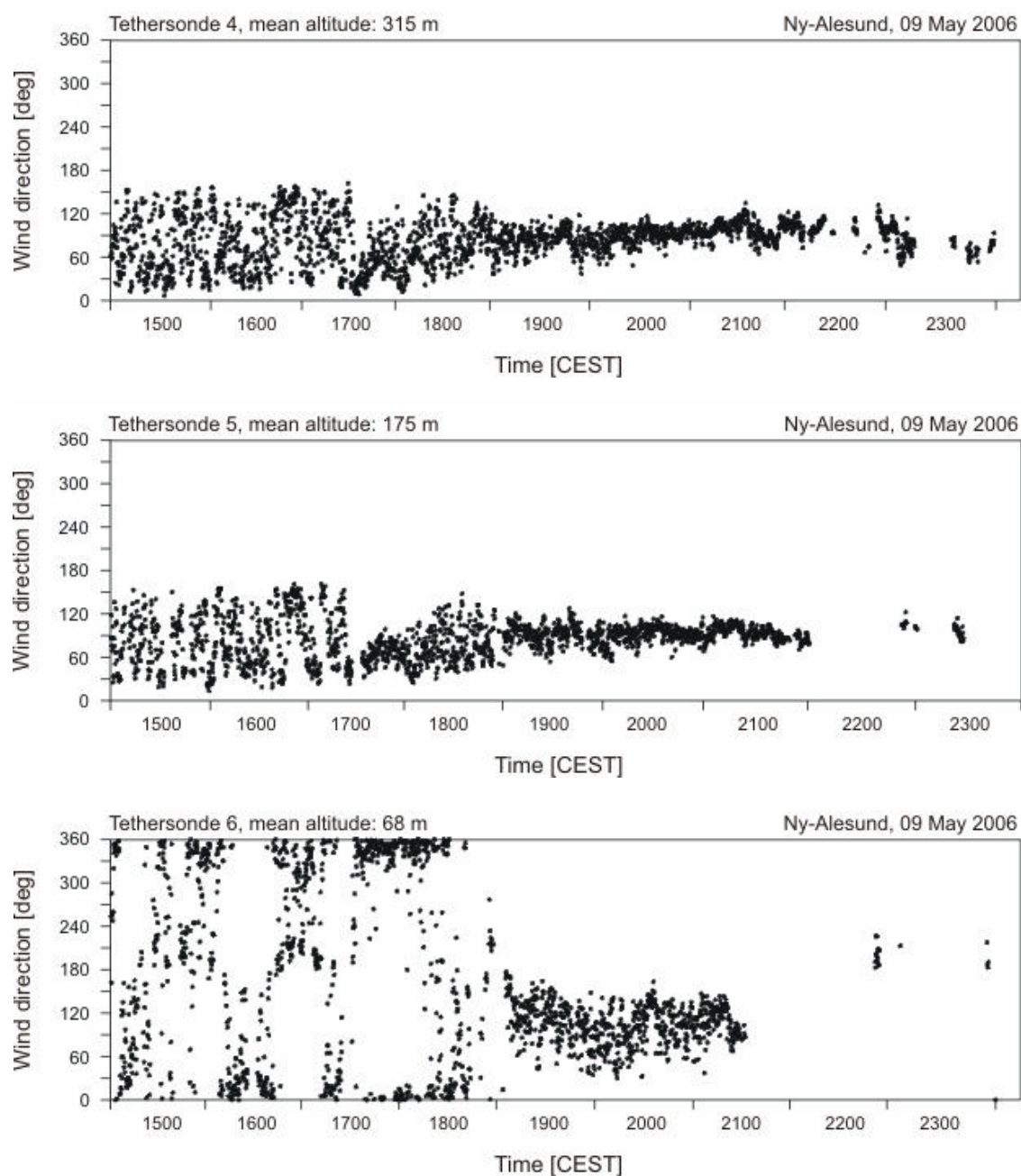


Figure 5.3: Time series of wind direction derived from tether sonde soundings at six different levels over Ny-Ålesund (Svalbard), 9 May 2006, 1500 to 2359 CEST.

Frequency distribution of wind direction (1500 to 2359 CEST)

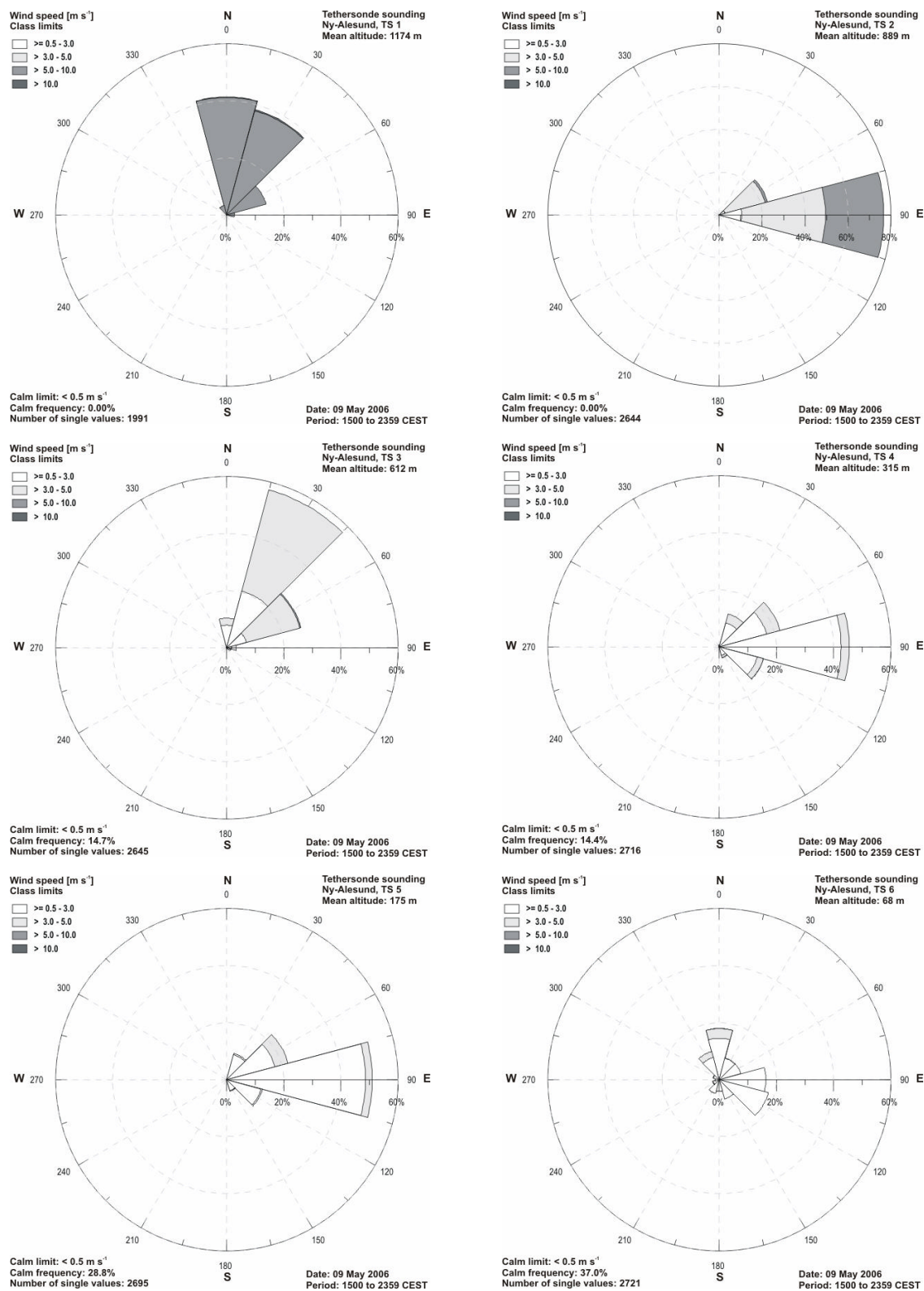
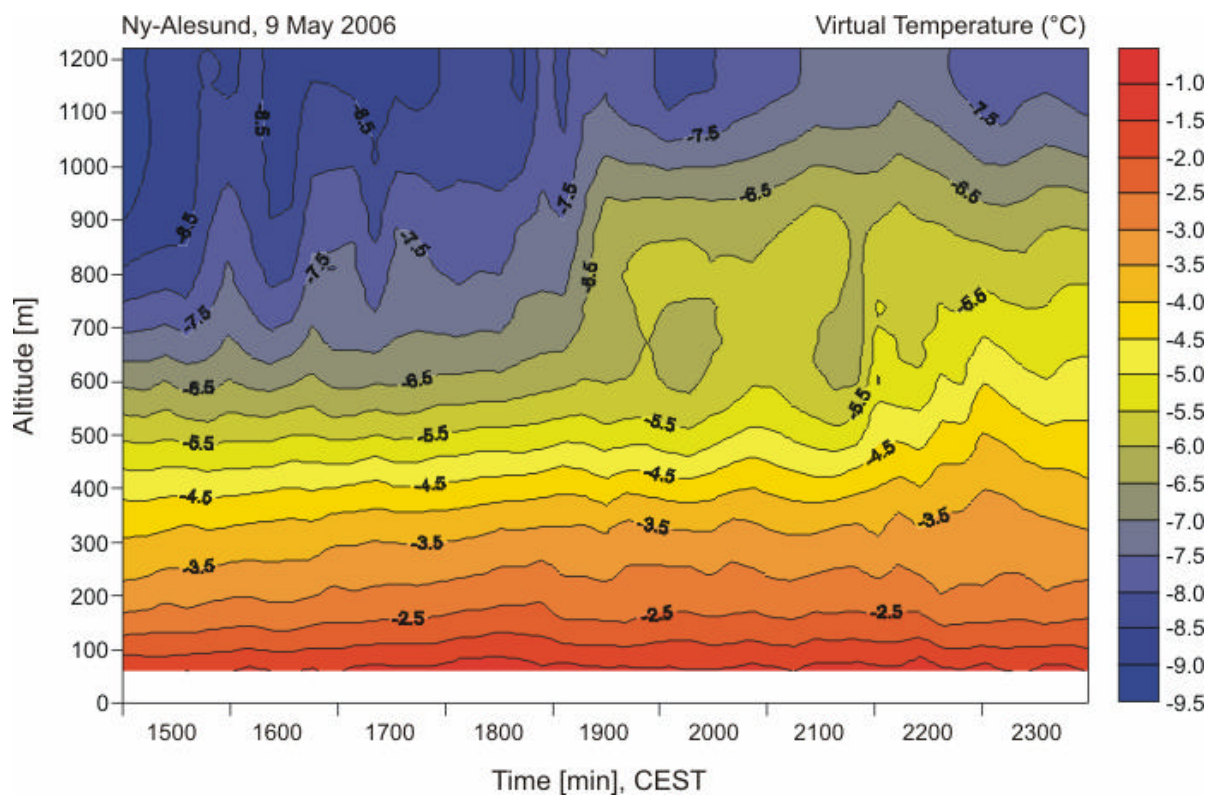
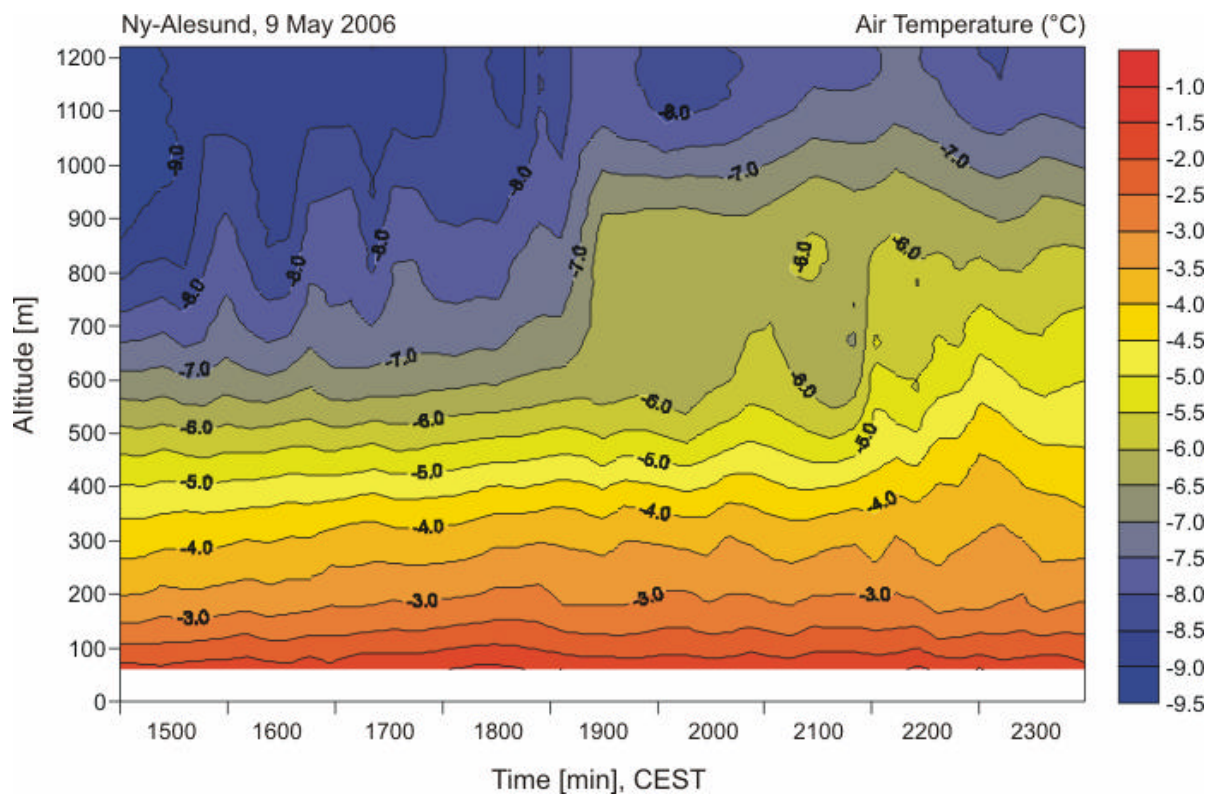
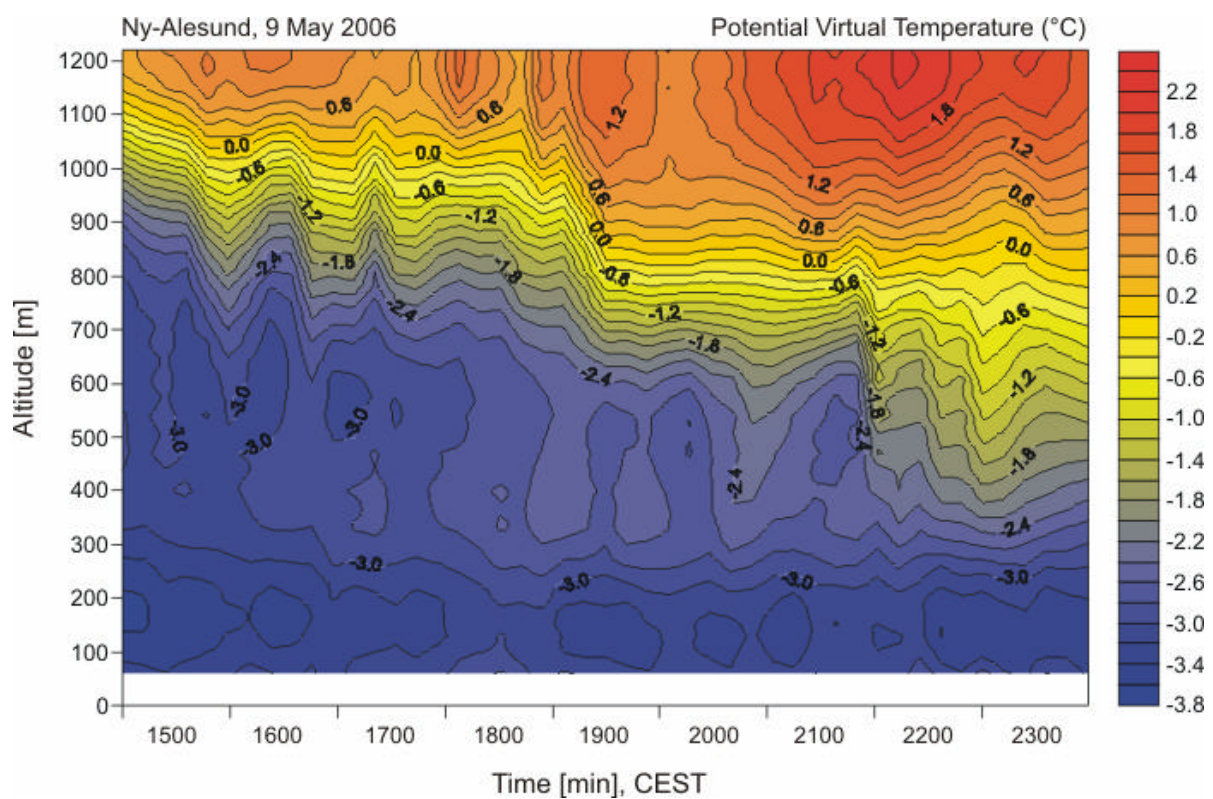
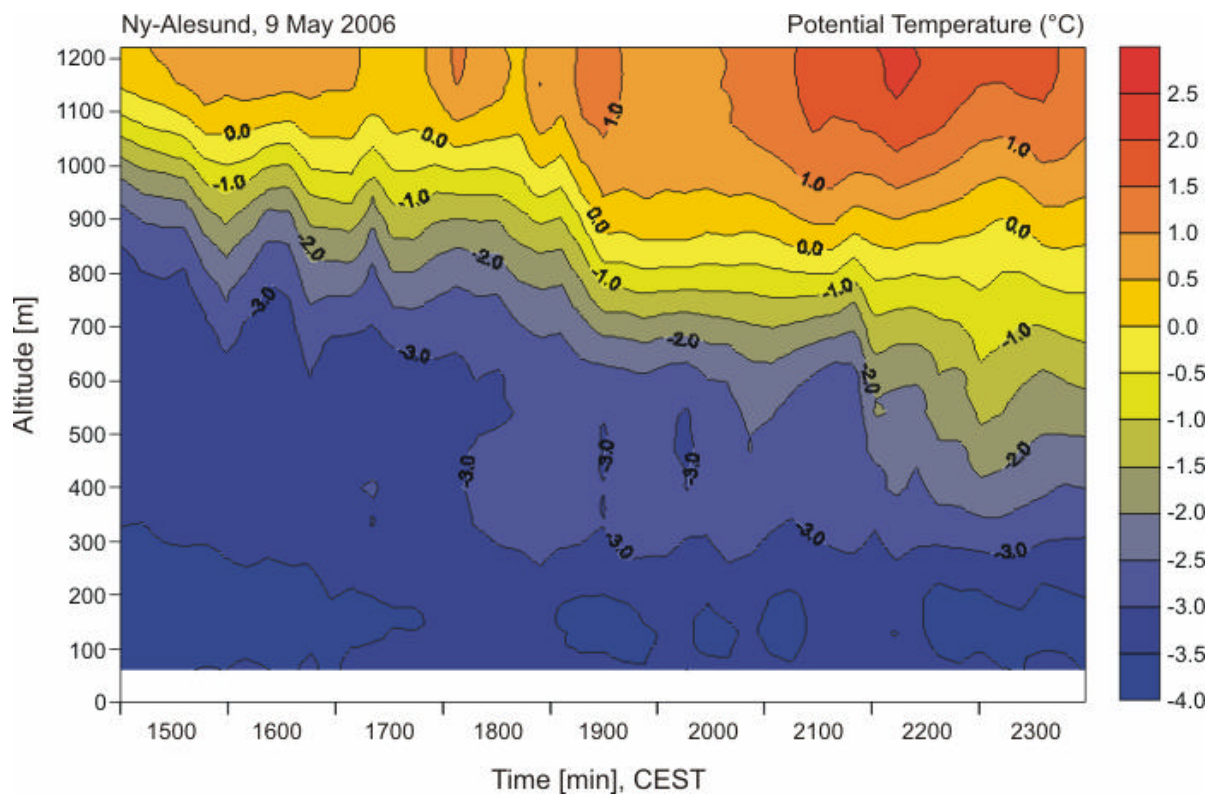
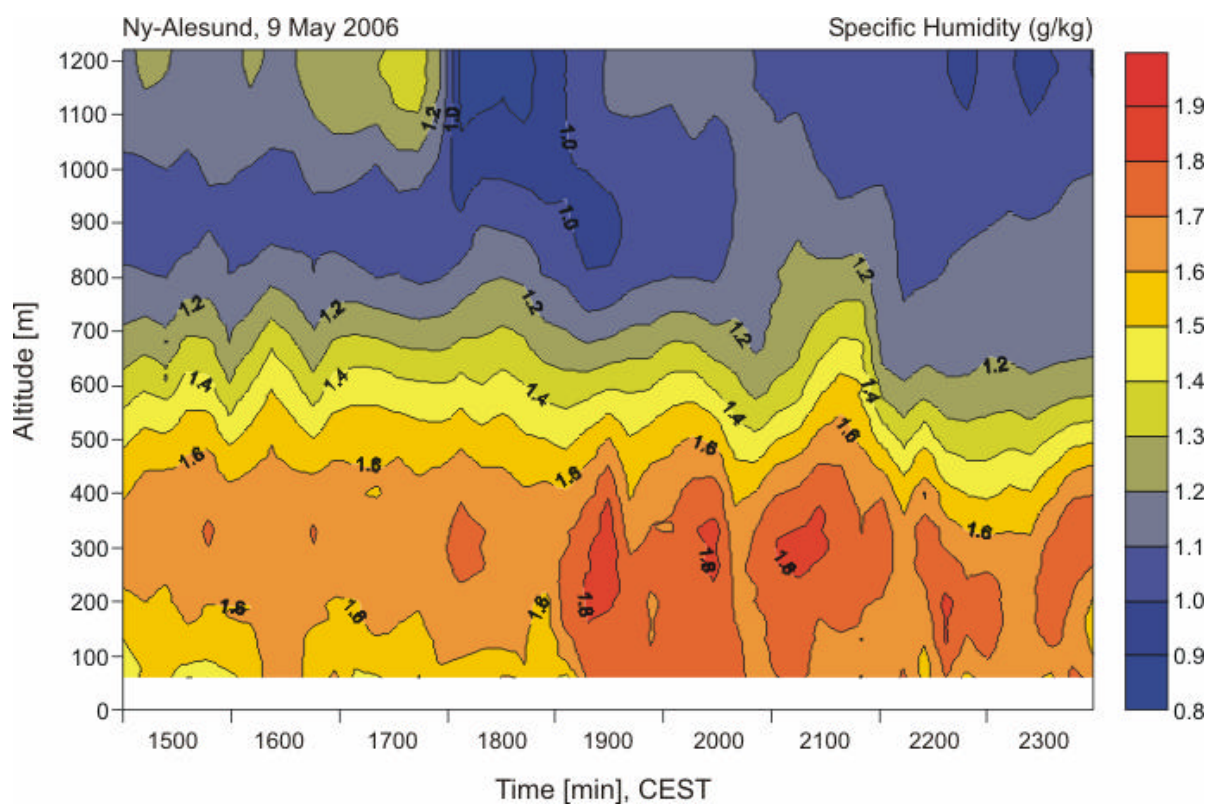
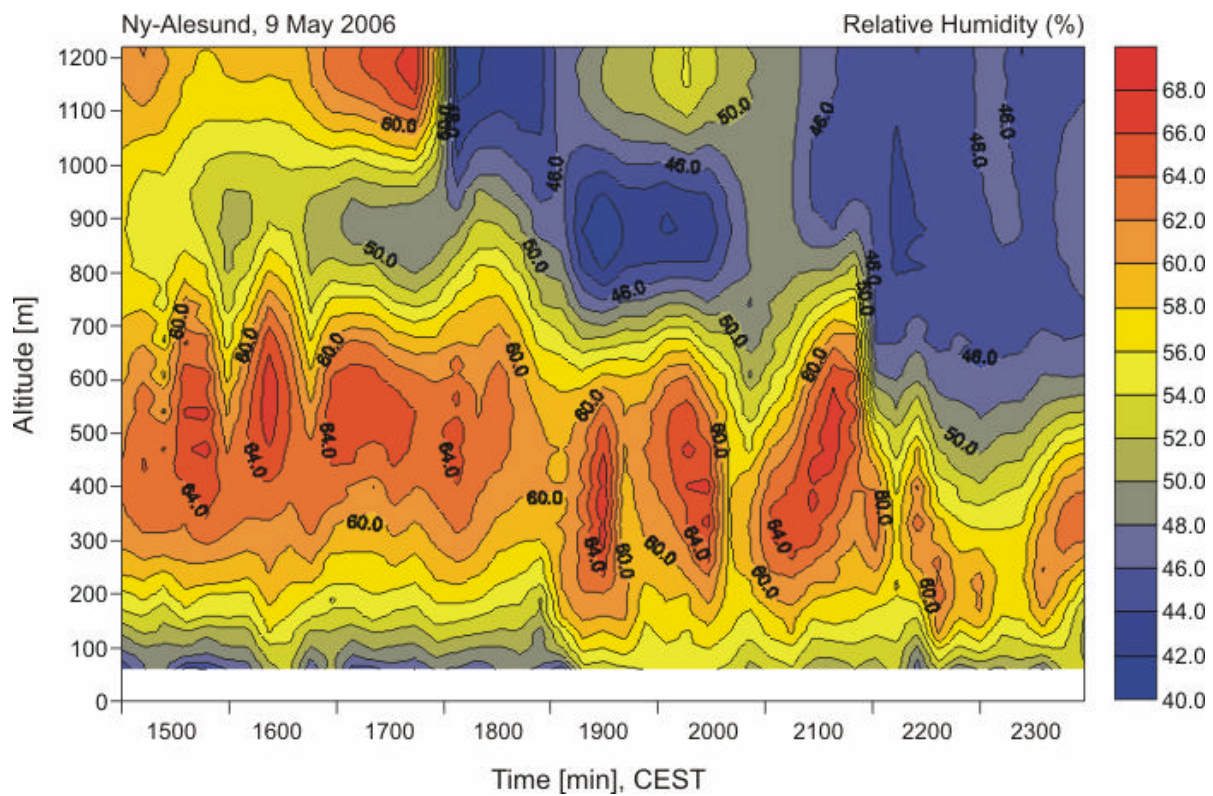


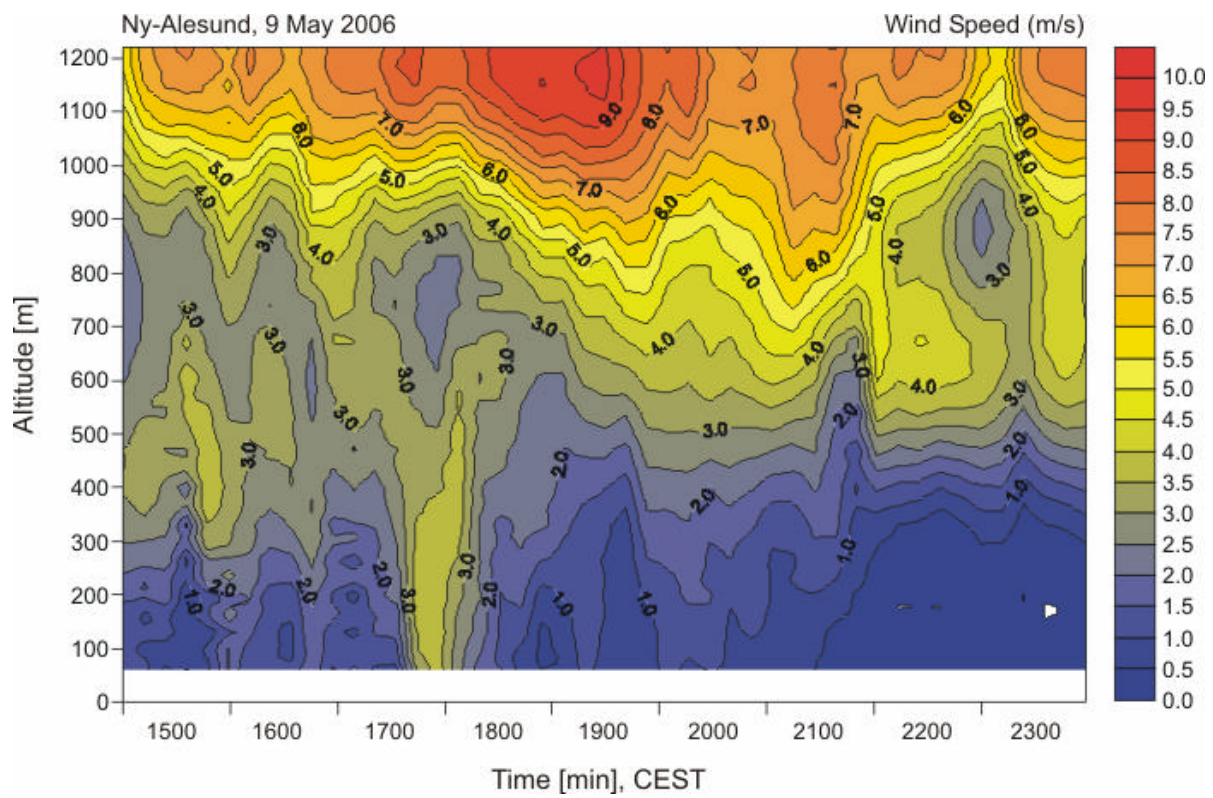
Figure 5.4: Frequency distribution of wind direction with polar coordinates derived from tethered soundings at six different levels over Ny-Ålesund (Svalbard), 9 May 2006, 1500 to 2359 CEST.

Hovmoeller plots (time/height) of meteorological elements (1500 to 2359 CEST)









5.2.3 Vertical sounding on 10 May 2006

Time series of wind direction (0300 to 1000 CEST)

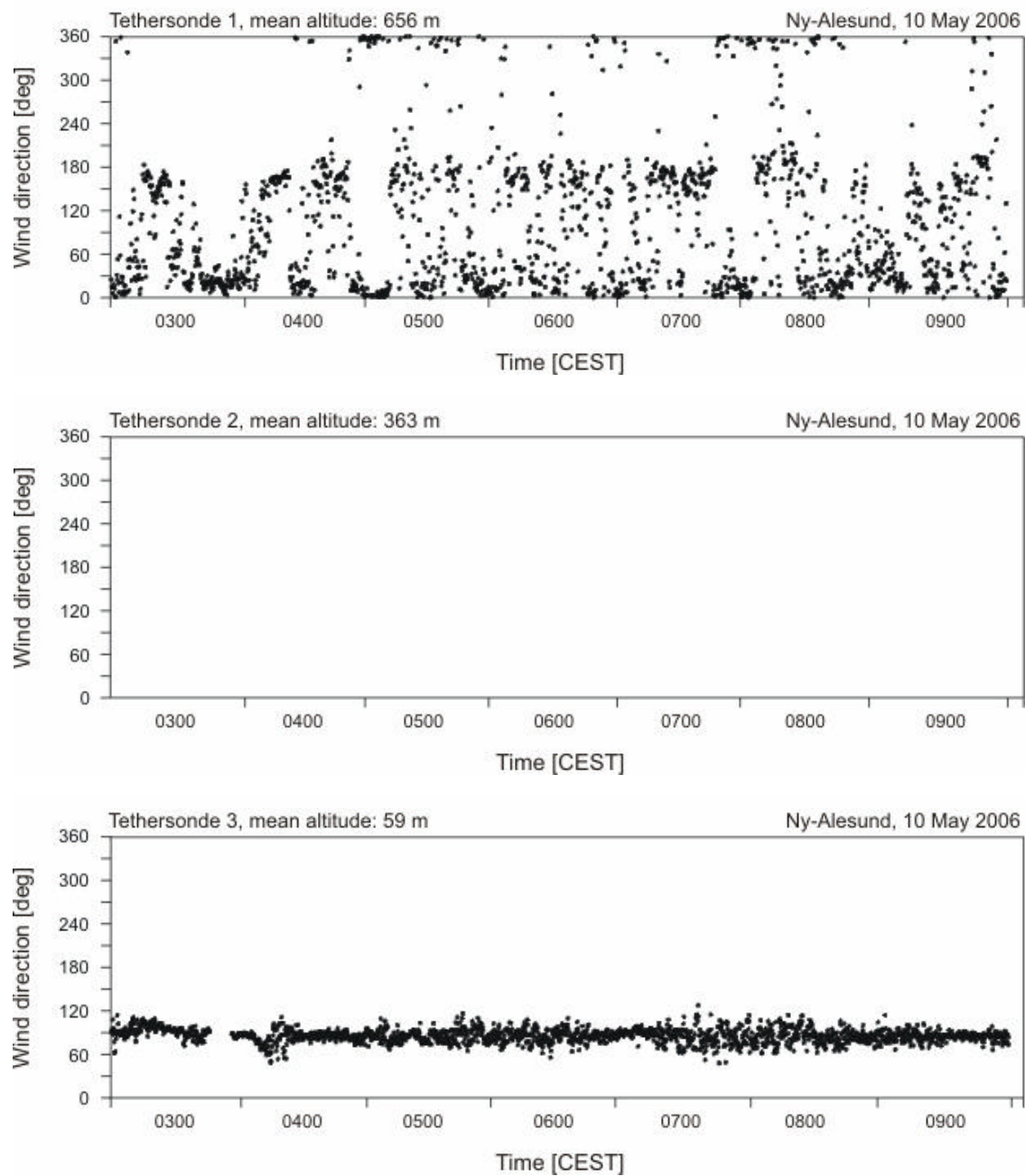


Figure 5.5: Time series of wind direction derived from tethered sonde soundings at three different levels over Ny-Ålesund (Svalbard), 10 May 2006, 0300 to 1000 CEST. No data was available from tethered sonde 2.

Frequency distribution of wind direction (0300 to 1000 CEST)

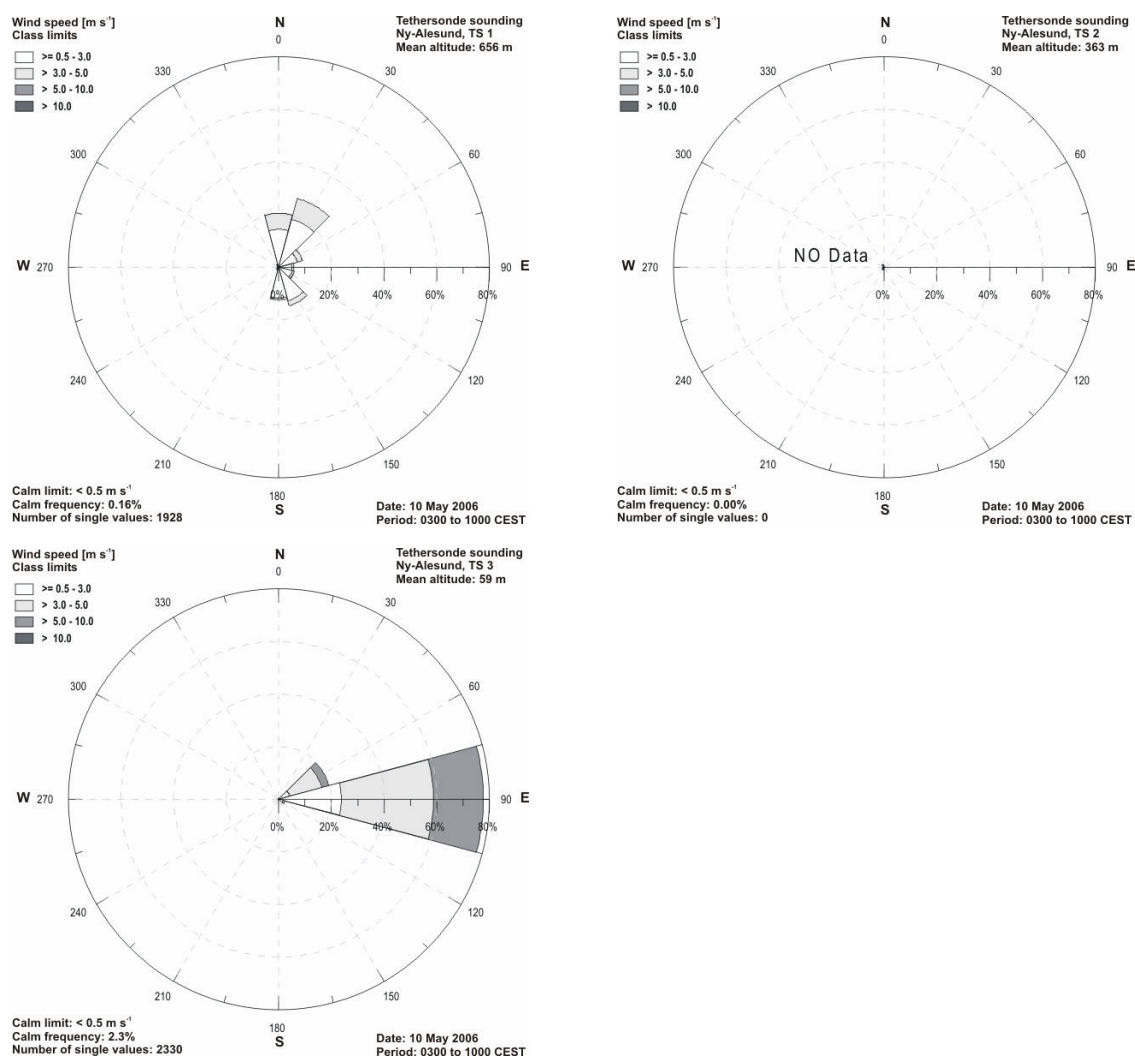
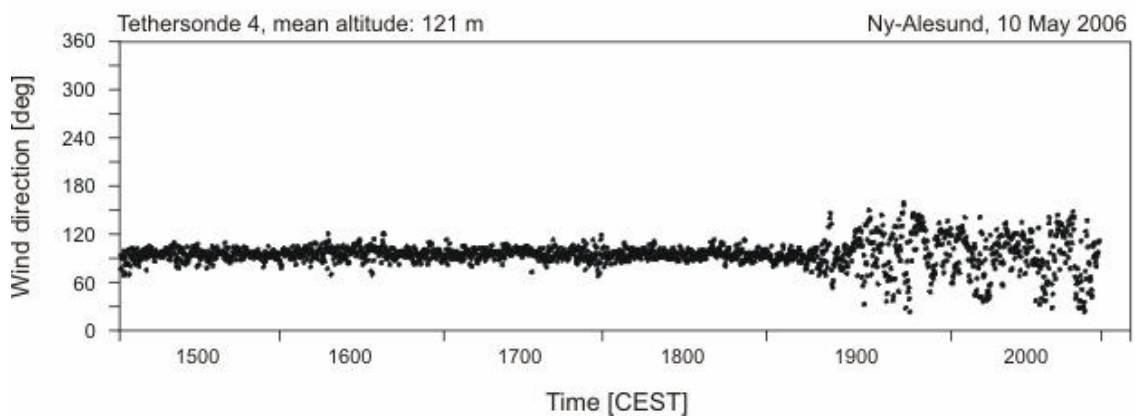
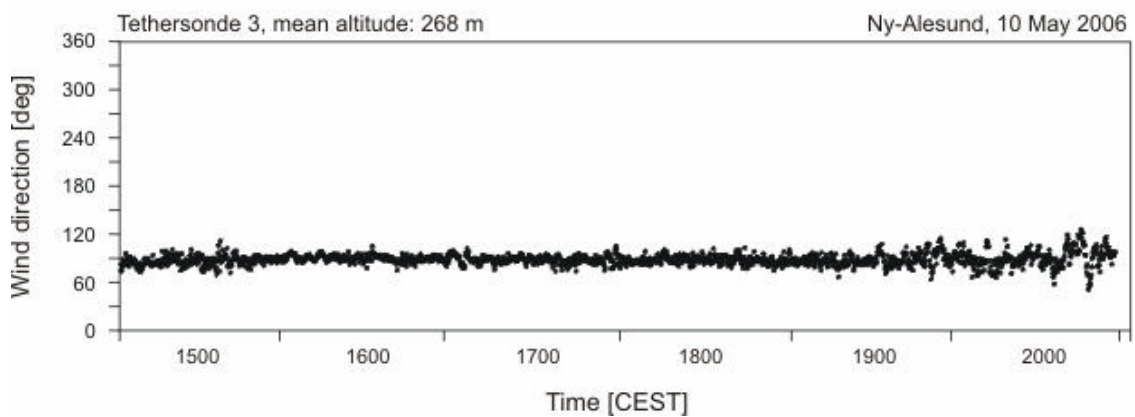
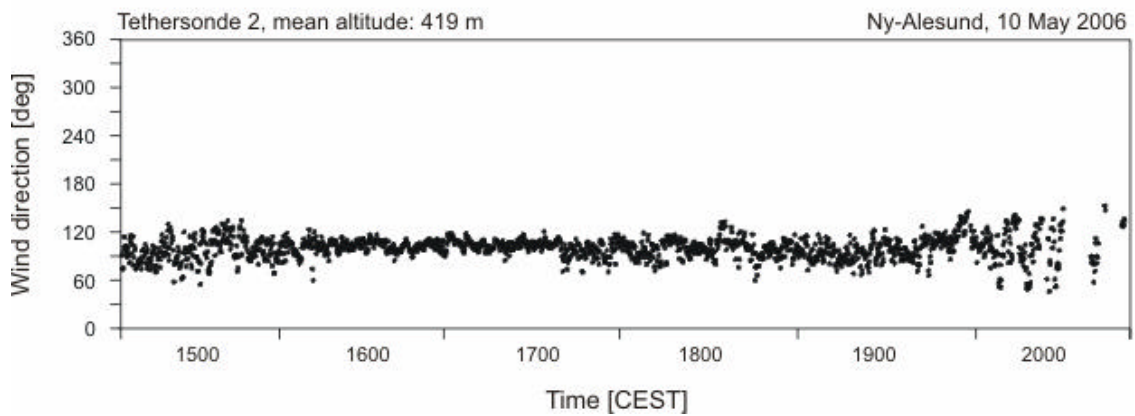
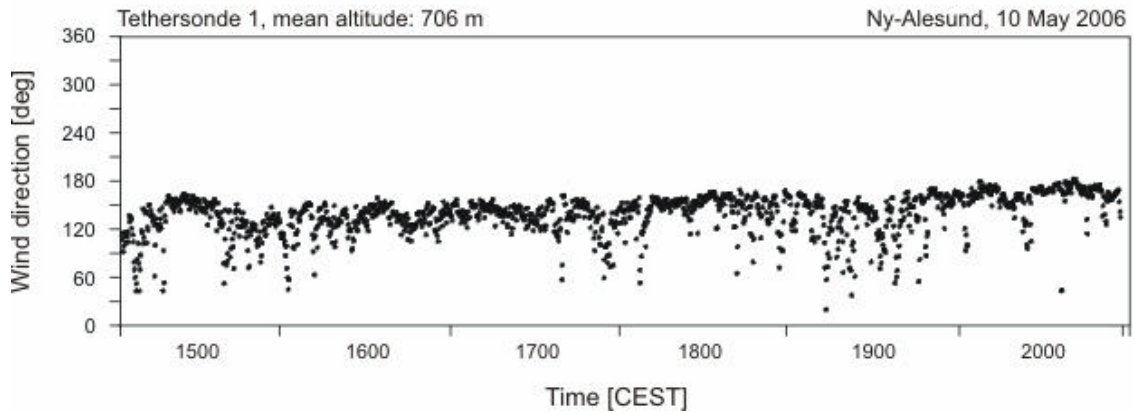


Figure 5.6: Frequency distribution of wind direction with polar coordinates derived from tethered soundings at six different levels over Ny-Ålesund (Svalbard), 10 May 2006, 0300 to 1000 CEST. No data was available from tethered sonde 2.

Time series of wind direction (1500 to 2100 CEST)



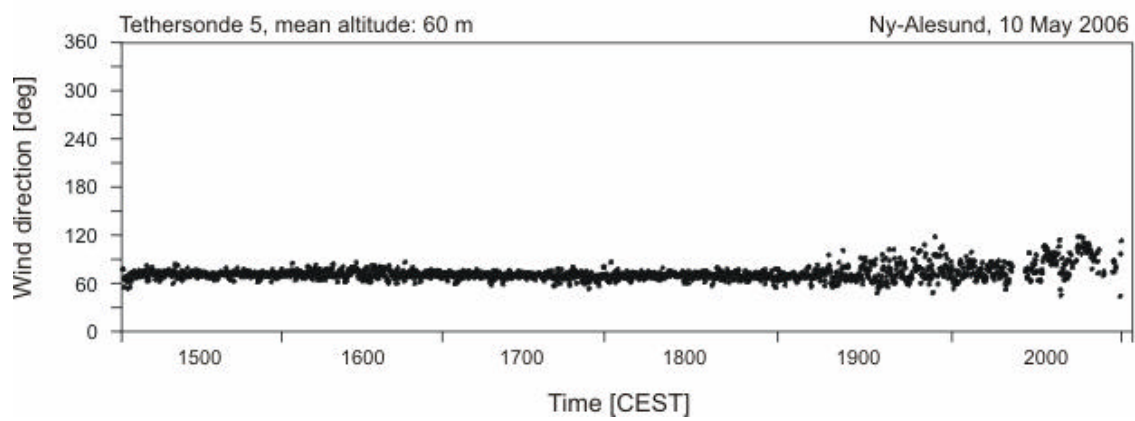


Figure 5.7: Time series of wind direction derived from tethersonde soundings at five different levels over Ny-Ålesund (Svalbard), 10 May 2006, 1500 to 2100 CEST.

Frequency distribution of wind direction (1500 to 2100 CEST)

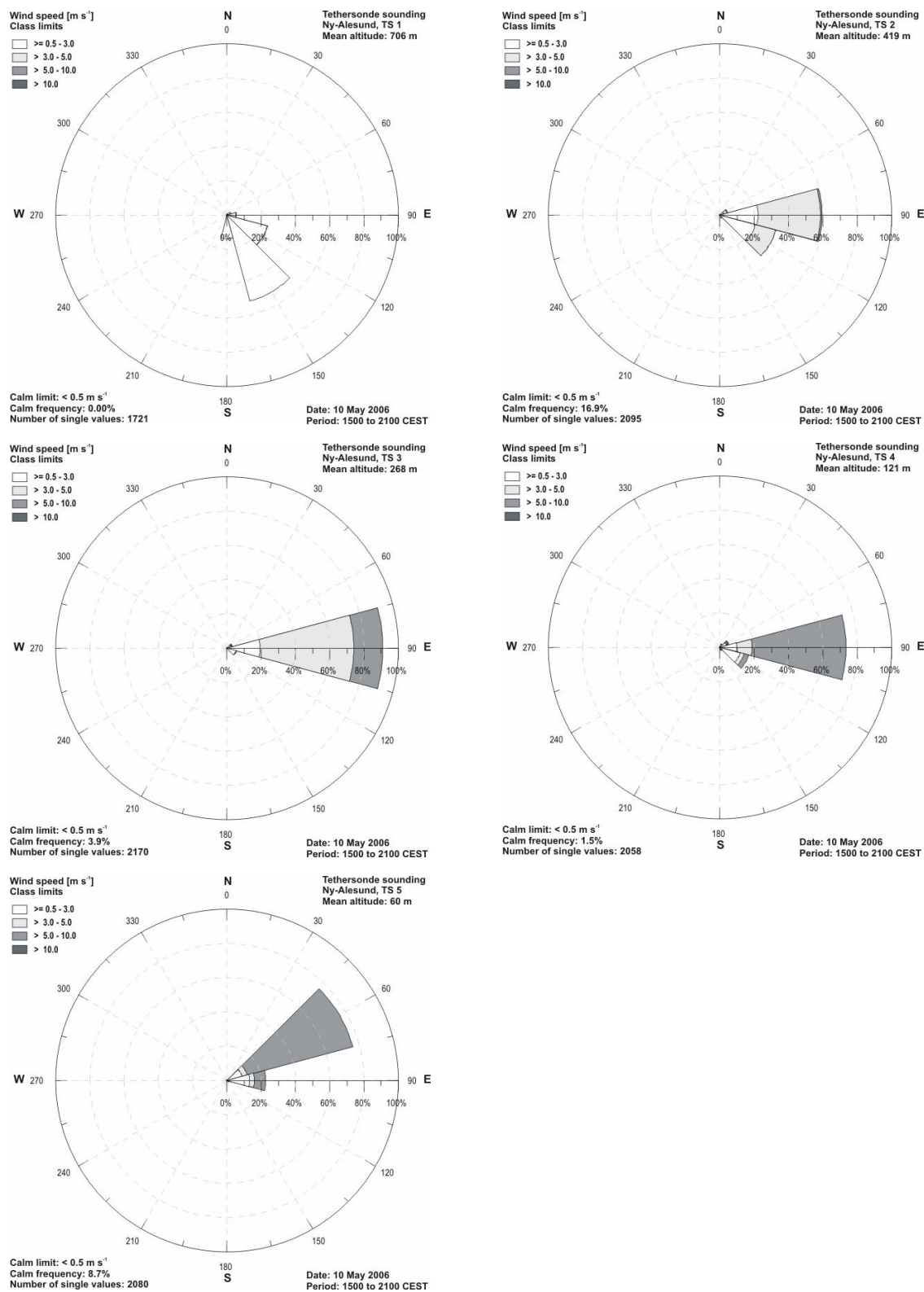
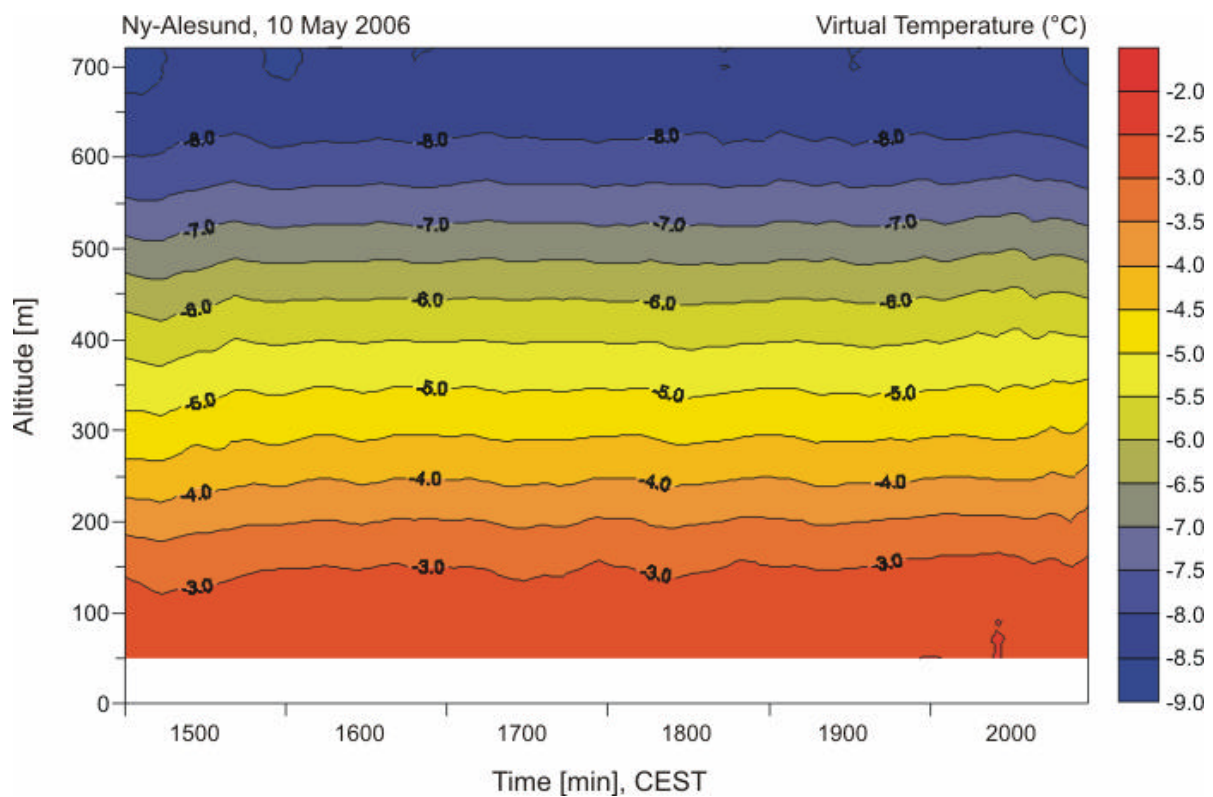
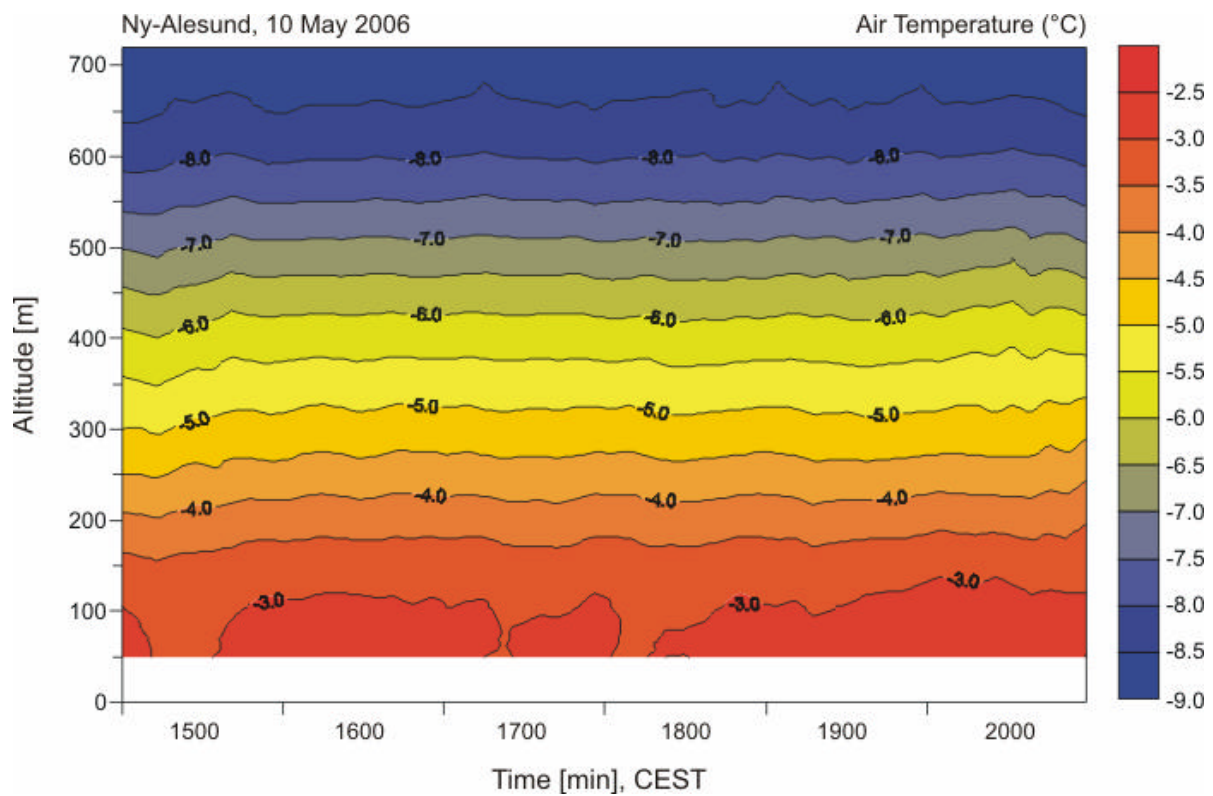
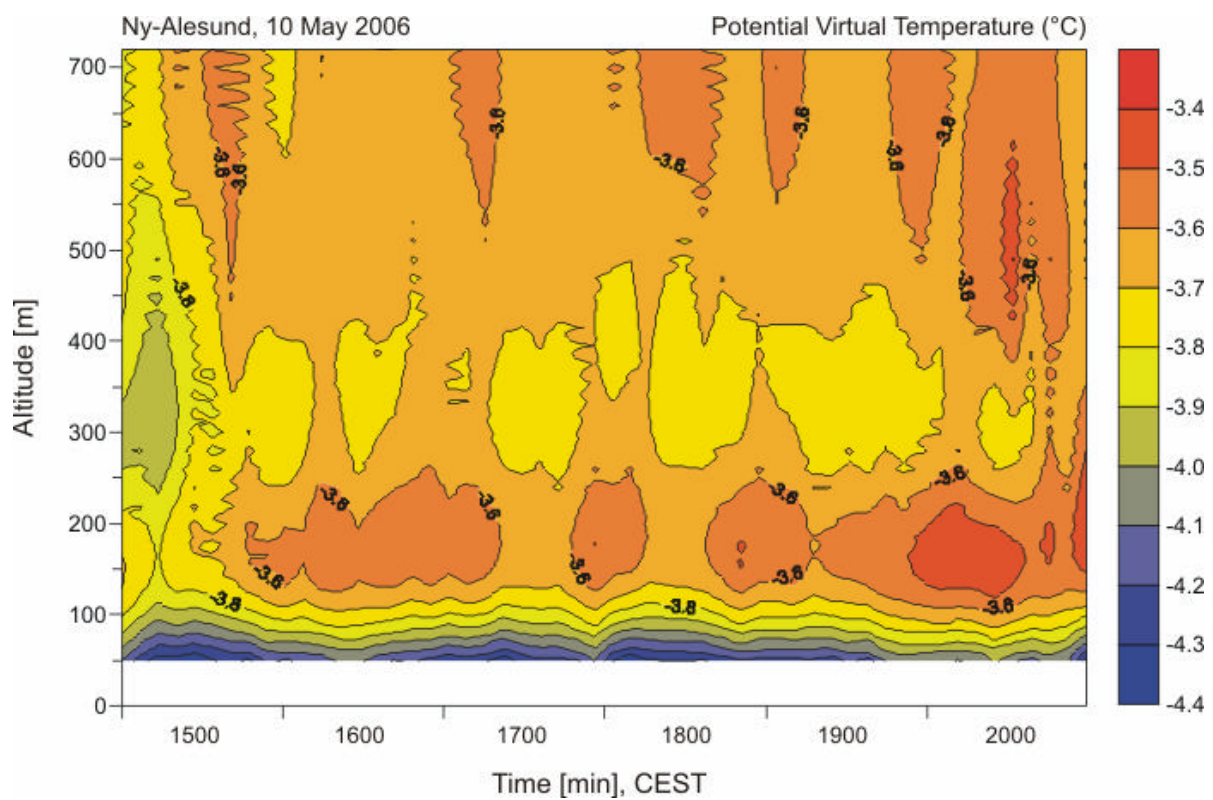
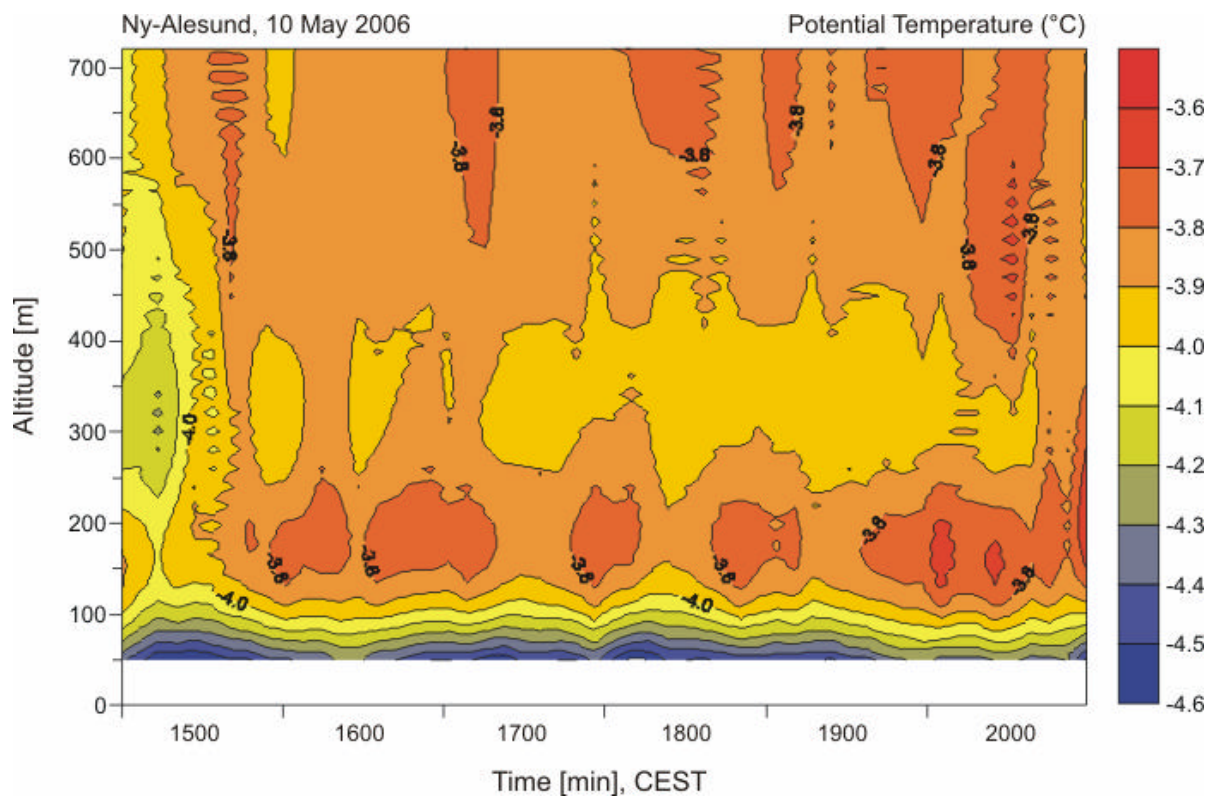
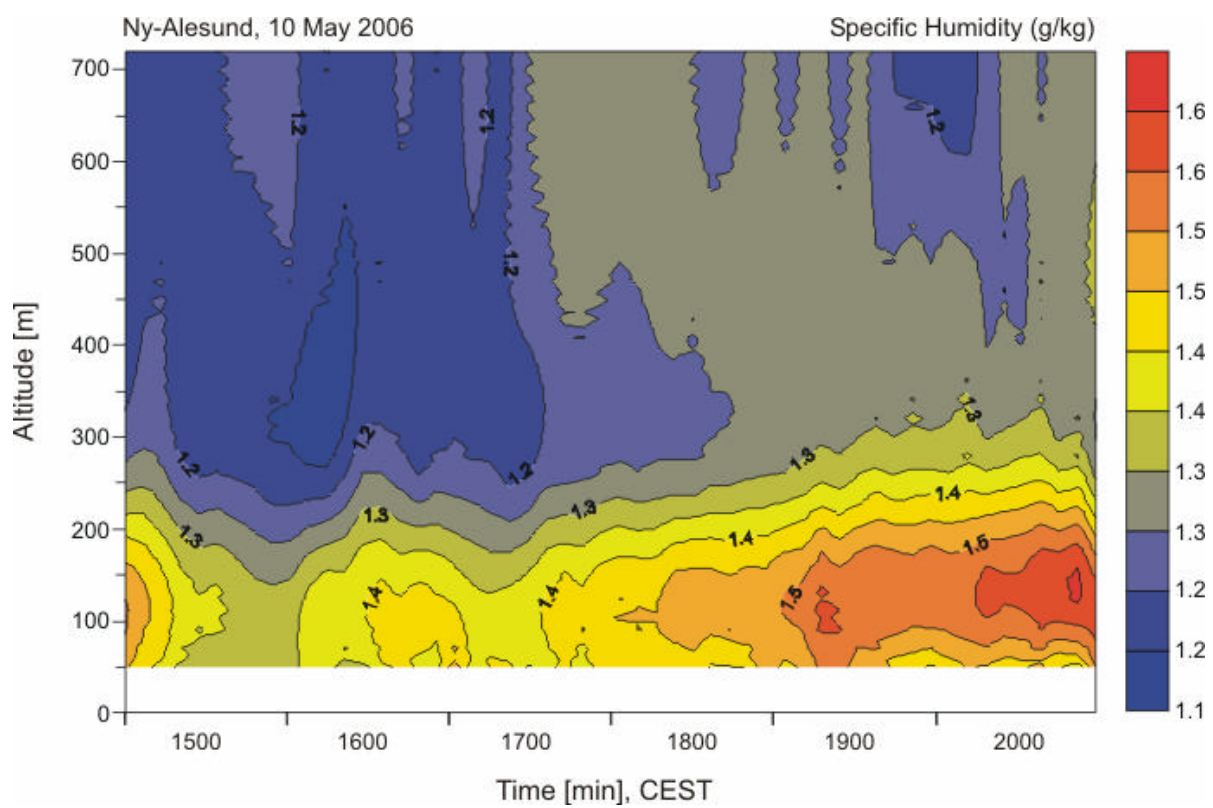
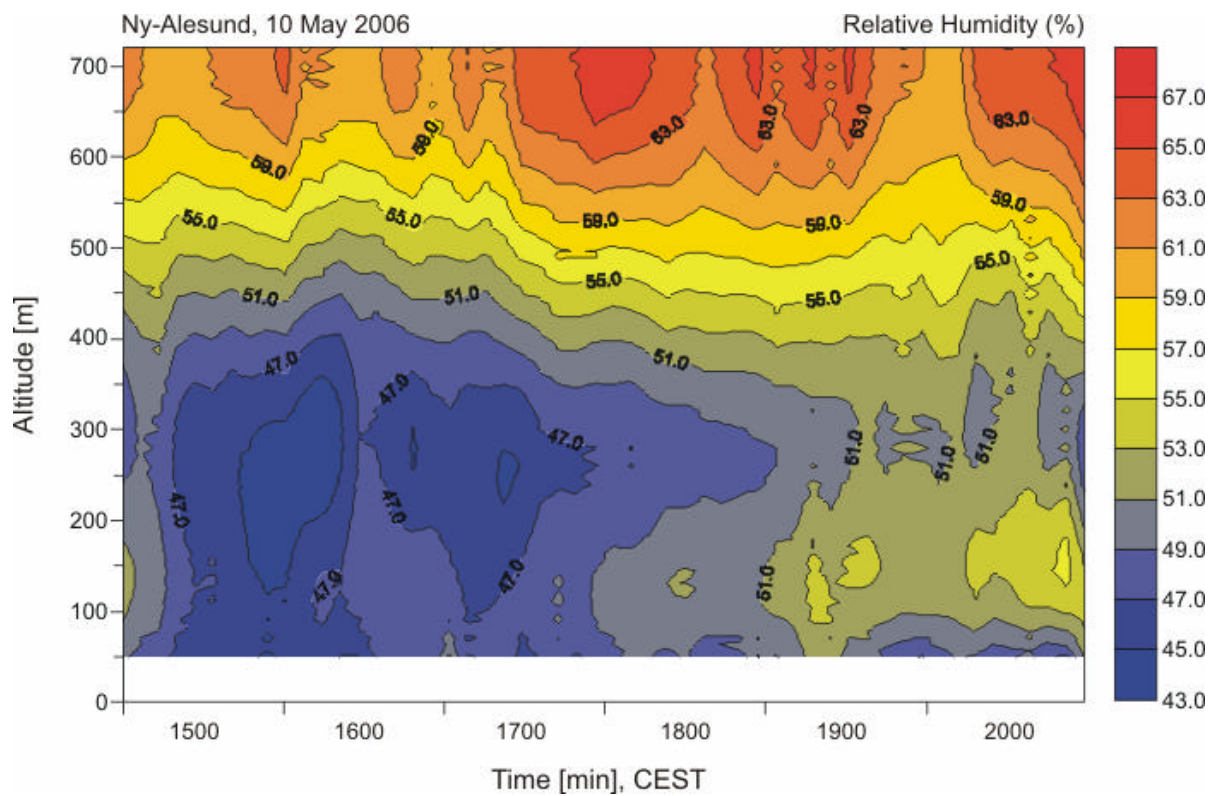


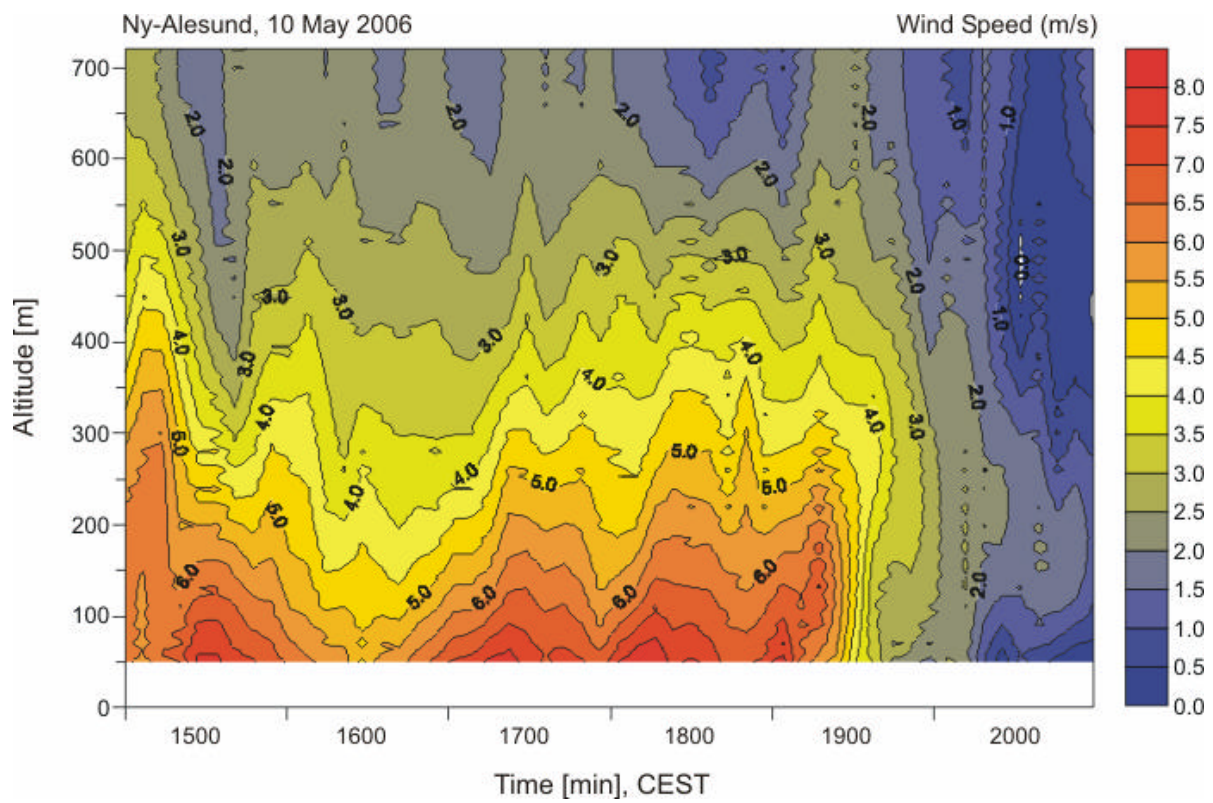
Figure 5.8: Frequency distribution of wind direction with polar coordinates derived from tethersonde soundings at six different levels over Ny-Ålesund (Svalbard), 10 May 2006, 1500 to 2100 CEST.

Hovmoeller plots (time/height) of meteorological elements (1500 to 2059 CEST)



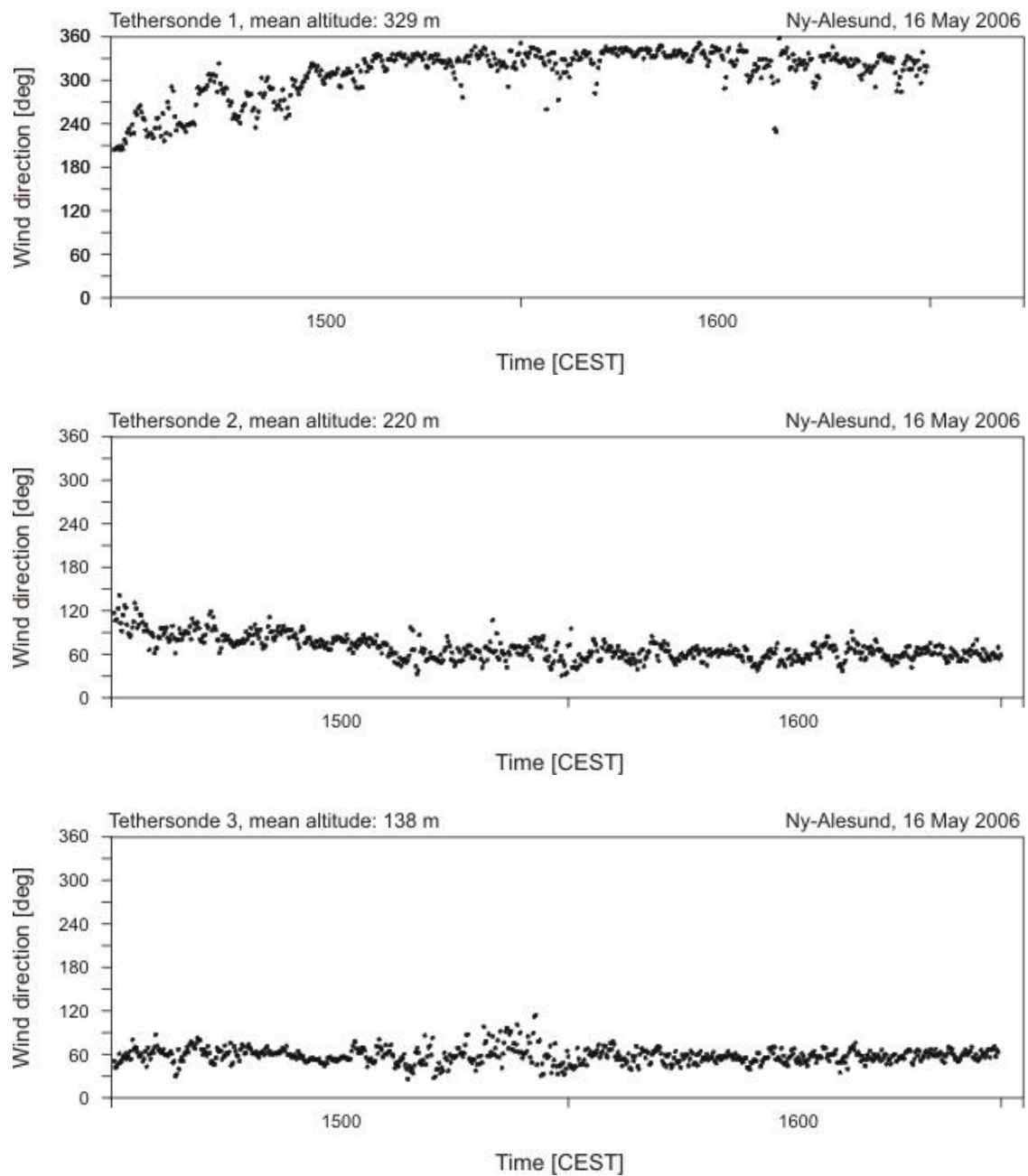






5.2.4 Vertical sounding on 16 May 2006

Time series of wind direction (1500 to 1700 CEST)



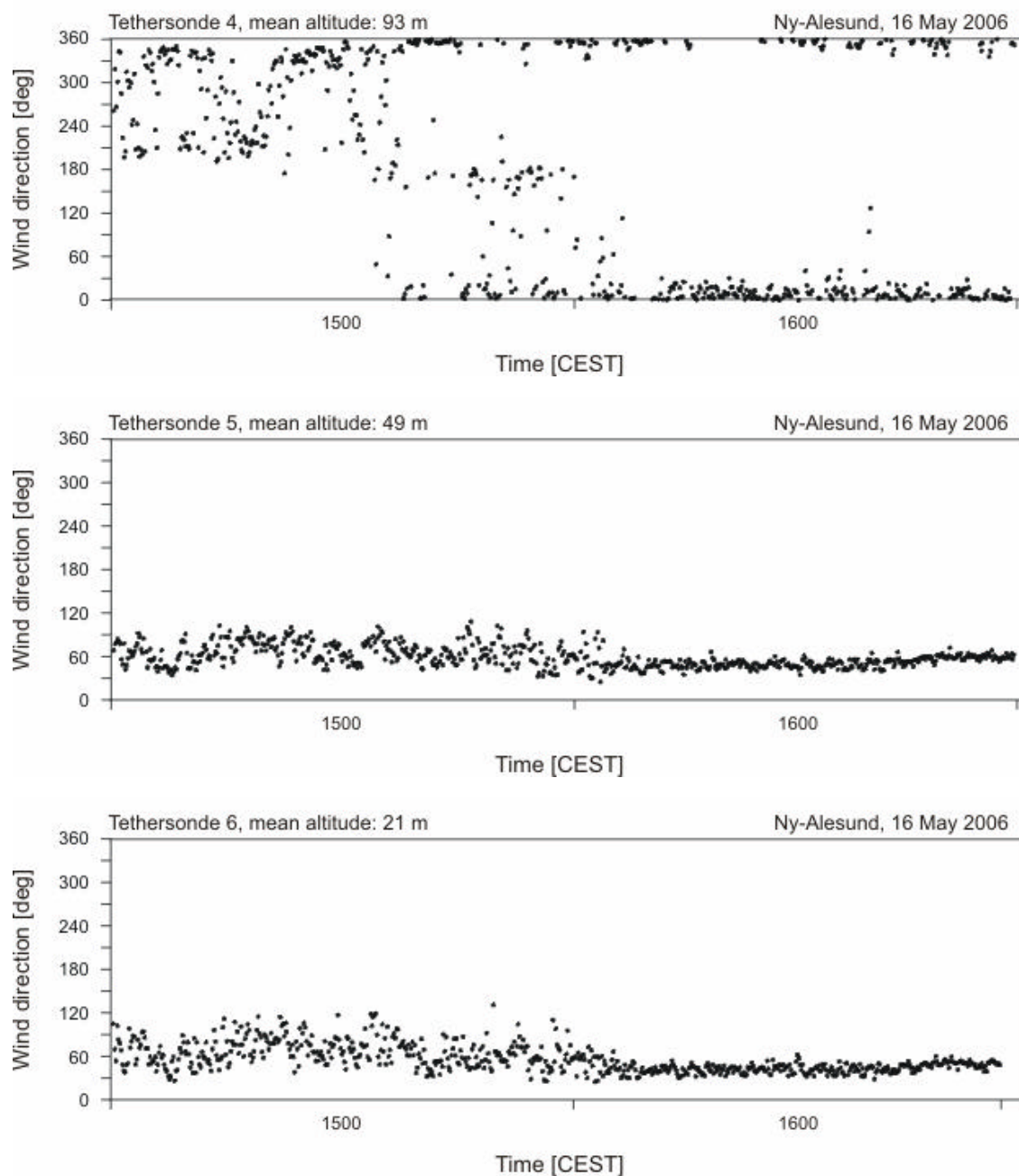


Figure 5.9: Frequency distribution of wind direction with polar coordinates derived from tethered sounding at six different levels over Ny-Ålesund (Svalbard), 16 May 2006, 1500 to 1700 CEST.

Frequency distribution of wind direction (1500 to 1700 CEST)

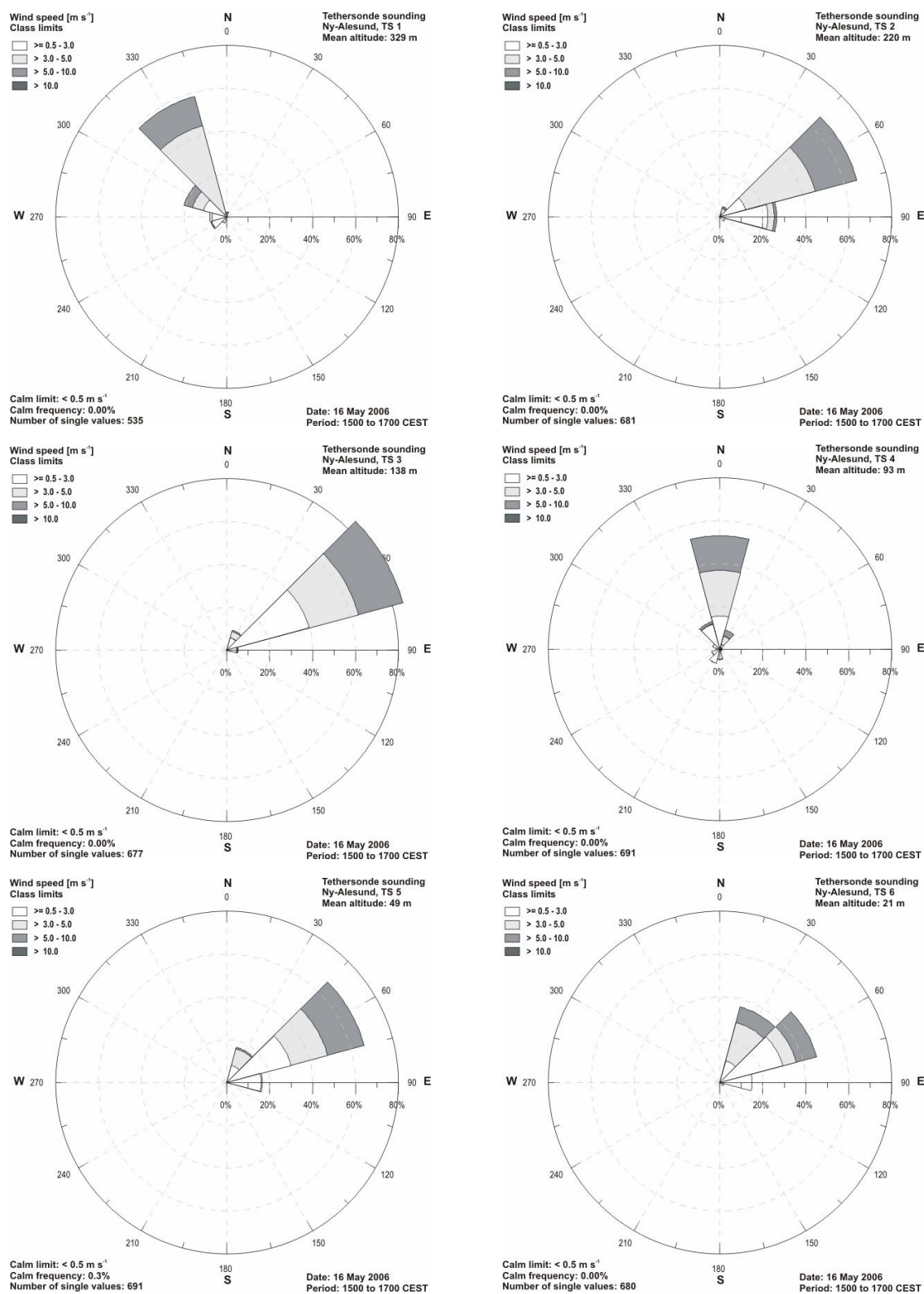
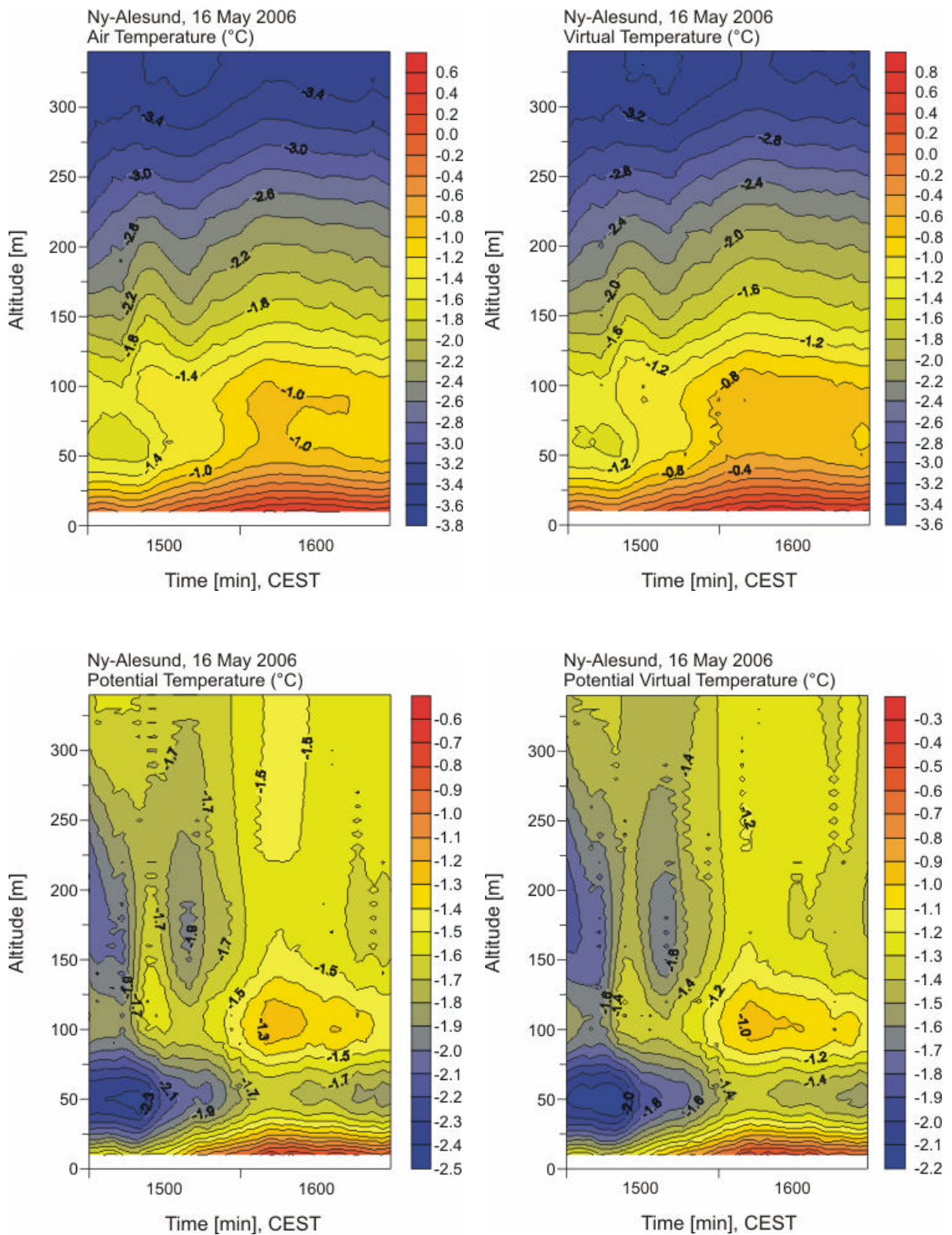
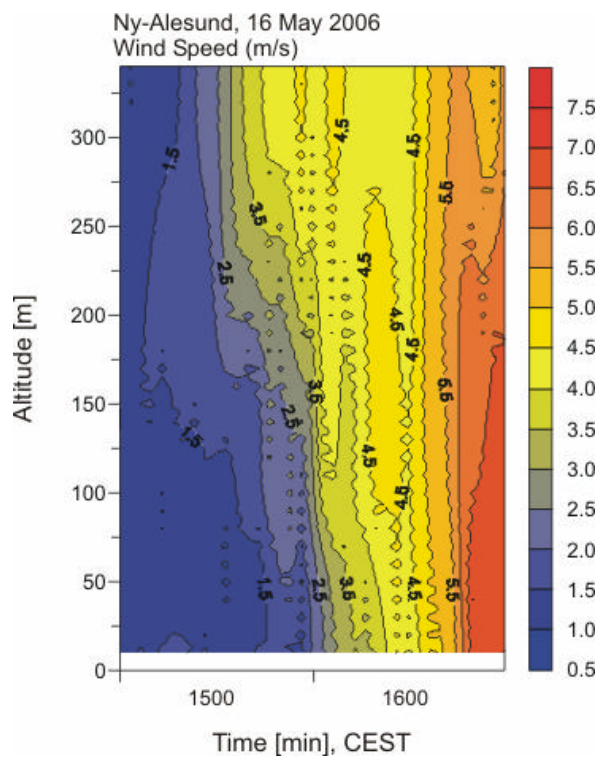
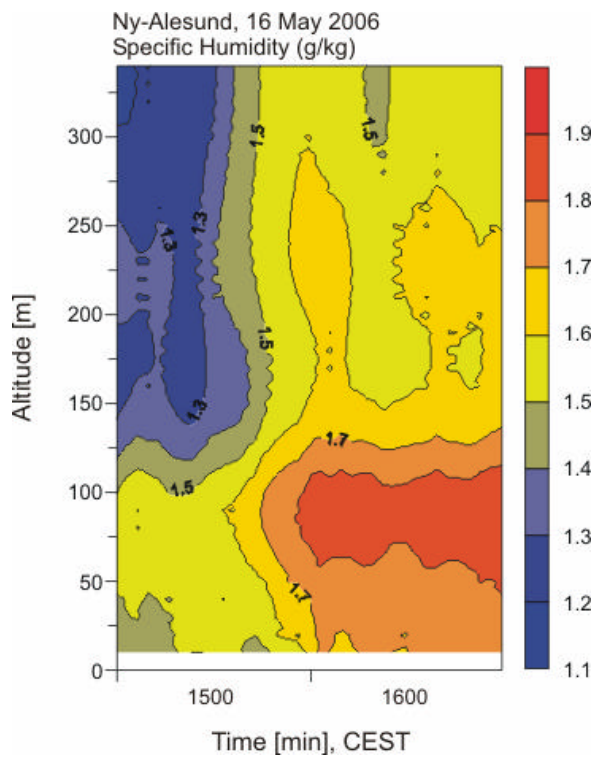
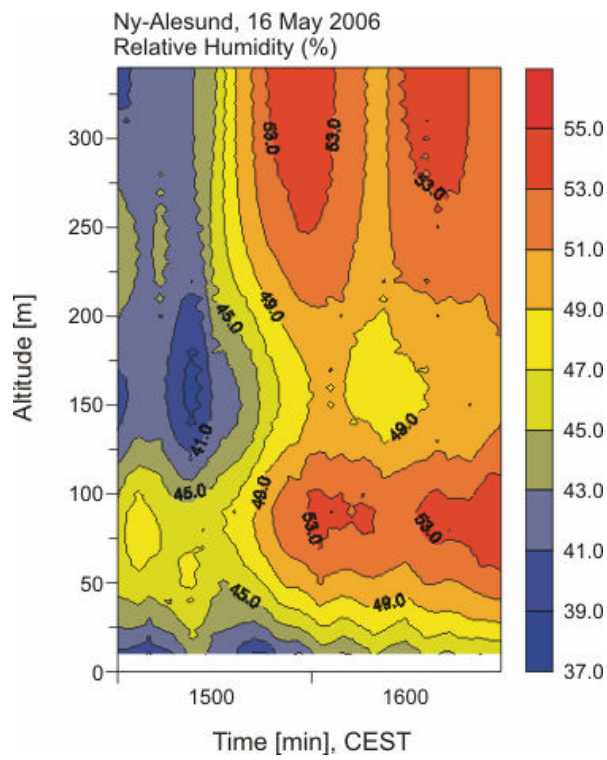


Figure 5.10: Frequency distribution of wind direction with polar coordinates at Ny-Alesund (Svalbard), 16 May 2006, 1500 to 1700 CEST, derived from tethersonde soundings.

Hovmoeller plots (time/height) of meteorological elements (1500 to 1659 CEST)





6 Data archived at Ny-Ålesund (CDs)

CD-Nummer		CD-Inhalt
CD1		Rohdaten CSAT3, ARCTEX-Gradientmast und Strahlungsbock, AWI-Met-Turm, Radiosonden
CD2		CSAT3-Originale und ausgelesene Dateien mit CSAT_B2A.EXE (Teil 1), 07.05.2006 bis 10.05.2006
CD3		CSAT3 ausgelesene Dateien mit CSAT_B2A.EXE (Teil 2), 11.05.2006 bis 15.05.2006
CD4		CSAT3 ausgelesene Dateien mit CSAT_B2A.EXE (Teil 3), 16.05.2006 bis 19.05.2006
CD5		TK 2 Eingabe- und Ausgabedateien (Teil 1), AT_0001.dat bis AT_0006.dat
CD6		TK 2 Eingabe- und Ausgabedateien (Teil 2), AT_0007.dat bis AT_0011.dat
CD7		TK 2 Eingabe- und Ausgabedateien (Teil 3), AT_0010.dat bis AT_0013.dat + Fesselballondaten + Scintillometer

Example for launch details at Ny-Ålesund radiosonde station from header (RS90-AG)

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Bisher erschienene Arbeiten der Reihe "Arbeitsergebnisse Universität Bayreuth, Abteilung Mikrometeorologie":

Nr	Author(s)	Title	Year
01	Foken	Der Bayreuther Turbulenzknecht	01/1999
02	Foken	Methode zur Bestimmung der trockenen Deposition von Bor	02/1999
03	Liu	Error analysis of the modified Bowen ratio method	02/1999
04	Foken et al.	Nachfrostgefährdung des ÖBG	03/1999
05	Hierteis	Dokumentation des Experimentes Dlouhá Louka	03/1999
06	Mangold	Dokumentation des Experimentes am Standort Weidenbrunnen, Juli/August 1998	07/1999
07	Heinz et al.	Strukturanalyse der atmosphärischen Turbulenz mittels Wavelet-Verfahren zur Bestimmung von Austauschprozessen über dem antarktischen Schelfeis	07/1999
08	Foken	Comparison of the sonic anemometer Young Model 81000 during VOITEX-99	10/1999
09	Foken et al.	Lufthygienisch-bioklimatische Kennzeichnung des oberen Egertales, Zwischenbericht 1999	11/1999
10	Sodemann	Stationsdatenbank zum BStMLU-Projekt Lufthygienisch-bioklimatische Kennzeichnung des oberen Egertales	03/2000
11	Neuner	Dokumentation zur Erstellung der meteorologischen Eingabedaten für das Modell BEKLIMA	10/2000
12	Foken et al.	Dokumentation des Experimentes VOITEX-99	10/2000
13	Bruckmeier et al.	Documentation of the experiment EBEX-2000, July 20 to August 24, 2000	01/2001
14	Foken et al.	Lufthygienisch-bioklimatische Kennzeichnung des oberen Egertales	02/2001
15	Göckede	Die Verwendung des Footprint-Modells nach Schmid (1997) zur stabilitätsabhängigen Bestimmung der Rauigkeitslänge	03/2001
16	Neuner	Berechnung der Evaporation im ÖBG (Universität Bayreuth) mit dem SVAT-Modell BEKLIMA	05/2001
17	Sodemann	Dokumentation der Software zur Bearbeitung der FINTUREX-Daten	08/2002
18	Göckede et al.	Dokumentation des Experiments STINHO-1	08/2002
19	Göckede et al.	Dokumentation des Experiments STINHO-2	12/2002
20	Göckede et al.	Characterisation of a complex measuring site for flux measurements	12/2002
21	Liebenthal	Strahlungsmessgerätevergleich während des Experiments STINHO-1	01/2003
22	Mauder et al.	Dokumentation des Experiments EVA_GRIPS	03/2003
23	Mauder et al.	Dokumentation des Experimentes LITFASS-2003, Dokumentation des Experimentes GRASATEM-2003	12/2003
24	Thomas et al.	Documentation of the WALDATEM-2003 Experiment	05/2004
25	Göckede et al.	Qualitätsbegutachtung komplexer mikrometeorologischer Messstationen im Rahmen des VERTIKO-Projekts	11/2004
26	Mauder & Foken	Documentation and instruction manual of the eddy covariance software package TK2	12/2004
27	Herold et al.	The OP-2 open path infrared gas analyser for CO ₂ and H ₂ O	01/2005
28	Ruppert	ATEM software for atmospheric turbulent exchange measurements using eddy covariance and relaxed eddy accumulation systems and Bayreuth whole-air REA system setup	04/2005
29	Foken (Ed.)	Klimatologische und mikrometeorologische Forschungen im Rahmen des Bayreuther Institutes für Terrestrische Ökosystemforschung (BITÖK), 1989-2004	06/2005
30	Siebeke & Serafimovich	Ultraschallanemometer-Überprüfung im Windkanal der TU Dresden 2007	04/2007
31	Lüers & Bareiss	The Arctic Turbulence Experiment 2006 PART 1: Technical documentation of the ARCTEX 2006 campaign, May, 2nd to May, 20th 2006	08/2007
32	Lüers & Bareiss	The Arctic Turbulence Experiment 2006 PART 2: Near surface measurements during the ARCTEX 2006 campaign, May, 2nd to May, 20th 2006	08/2007
33	Bareiss & Lüers	The Arctic Turbulence Experiment 2006 PART 3: Aerological measurements during the ARCTEX 2006 campaign, May, 2nd to May, 20th 2006	08/2007